



Project No. 60251

**Volume 1 of 3
Quality Assurance Project Plan
& Appendices A-D
Remedial Investigation/Feasibility Study
American Chemical Services, Inc.
Griffith, Indiana**

**Prepared for:
American Chemical Services
Steering Committee
Chicago, Illinois**

**Prepared by:
Warzyn Engineering Inc.
Chicago, Illinois**

May 1989

QUALITY ASSURANCE PROJECT PLAN (QAPP) FOR
AMERICAN CHEMICAL SERVICES, INC.
GRIFFITH, INDIANA
REMEDIAL INVESTIGATION/FEASIBILITY STUDY

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1.0 INTRODUCTION

The objectives of this Remedial Investigation/Feasibility Study (RI/FS) are to evaluate the existence and magnitude of contamination, and recommend a cost effective, viable remedial action alternative(s) for mitigating the potential hazard posed by the site. Tasks are directed toward accomplishing these primary objectives. The American Chemical Services, Inc. (ACS) RI/FS is a Potentially Responsible Party (PRP) lead investigation.

The United States Environmental Protection Agency requires that PRP-lead investigations under CERCLA have an approved Quality Assurance Project Plan (QAPP) covering environmental measurements. It is the responsibility of the Respondents or their representatives to implement minimum procedures so that the accuracy, precision, completeness and representativeness of data collected are known and documented.

This QAPP presents the organization, objectives, functional activities and specific quality assurance (QA) and quality control (QC) activities associated with the Remedial Investigation/Feasibility Study (RI/FS) at American Chemical Services, Inc. in Griffith, Indiana. The QAPP is designed to achieve the specific quality goals of the RI/FS.

The QAPP has been prepared using the following guidance documents:

- U.S. EPA, Region V, December 1985, Preparation of Federal-Lead Remedial Investigation Quality Assurance Project Plans for Region V.
- U.S. EPA, December 1980, Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, QAMS-005/80.
- U.S. EPA, June 1986, Data Quality Objectives for the RI/FS Process, Doc. No. 9355.0-7A.
- U.S. EPA, Region V, Content Requirements for Quality Assurance Project Plans prepared by Cheng-Wen Tsai, QAS (Received 3/2/88).

Under the Superfund Amendments and Reauthorization Act of 1986 (SARA), it is recommended that the RI and FS are integrated so that parts of each are conducted concurrently. Therefore, the project will be conducted in several phases of investigation. Each phase will be designed to make optimal use of information as it is derived and to produce the information which is necessary to complete the FS. The QAPP is limited to applicable activities (i.e. tasks requiring the collection of data or measurements) within Phase I

and II; additional phases and associated QAPP agenda would be developed if and when it were to be determined that additional information would be required which had not been developed in Phases I and II. Activities and subtasks related to the field work are listed below. For a complete itemization of all tasks, refer to the attached Work Plan (Appendix A).

PHASE I - REMEDIAL INVESTIGATION

I. TASK 1 - PROBLEM DEFINITION

- A. Review Available Information
- B. Survey Site Boundaries
- C. Geophysical Survey
- D. Surface Water Survey
- E. Environmental Audit of ACS
- F. Establish Remedial Alternatives

II. TASK 2 - HYDROGEOLOGIC INVESTIGATION

- A. Characterize Flow System
- B. Initial Shallow Sampling

III. TASK 3 - NEAR SURFACE CONTAMINATION INVESTIGATION

- A. Waste Characterization

PHASE II - REMEDIAL INVESTIGATION

IV. TASK 4 - PHASE II SITE CHARACTERIZATION

- A. Groundwater Characterization
- B. Soil Contamination
- C. Groundwater Transport Model

PHASE III - REMEDIAL INVESTIGATION

V. ADDITIONAL CONTAMINATION INVESTIGATION

- A. Install Additional Monitoring Wells as Necessary
- B. Collect Additional Samples as Necessary

VI. ENDANGERMENT ASSESSMENT

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3.0 PROJECT DESCRIPTION

3.1 Site Description

The ACS site is located at 420 South Colfax Avenue, 1/2 mile southeast of Griffith, Indiana, in the northeast 1/4 of the southeast 1/4, Section 2, Township 35 North, Range 9 West, Lake County Indiana (Figure 1). Although the site name is ACS, the United States Environmental Protection Agency (U.S. EPA) has defined the site as including the inactive portion (about 15 acres) of the 31-acre municipal Griffith Landfill, the 2-acre Pazmey Corporation site (formerly Kapica Drum, Inc), and the ACS property (19 acres).

The topography at the site is almost level in the portion north of the railroad and rises slowly from 630 to 645 feet above MSL in the southern half of the site. Griffith Landfill has excavated about 30 feet of soil to the west of the ACS Off-Site Drum Containment Area near the southeast boundary of the ACS property, thus modifying the gently sloping topography. A marsh to the north of the landfill and west of the ACS property has a surface elevation of about 625 feet. The two major soils in the area are the Plainfield fine sand and the Maumee loamy fine sand with average hydraulic conductivities of 1.42×10^{-2} cm/sec.

There are no natural streams in the area of the site, but a marsh does exist immediately to the west of the northern half of the site. Man-made drainage ditches form the western border of the site and eventually enter Turkey Creek one mile to the south. A natural surface water drainage pond is located just to the west of the western boundary of the site, and a fire pond, in which rainwater is collected to be used in case of a fire at the facility, is located about 200 feet to the east. Turkey Creek, a small stream, flows about 1 mile south of the site and the Little Calumet River is located three miles to the north. Because of these natural and man-made features, the groundwater flow patterns at the site are not well defined, but the regional groundwater flow is reported to be to the northeast in the vicinity of the ACS site.

Based on existing data, the hydrostratigraphy at the site appears to consist of:

- An upper aquifer composed of fine to coarse-grained sand with fine to coarse gravel, and small amounts of peat and silt, about 20-feet thick.

- An intervening silty clay to clay unit containing discontinuous lenses of gravel, 15 to 30-feet thick.
- A lower sand and gravel aquifer, 90-feet thick.

A fourth soil unit consisting of thick, stiff clay is reported in the area, but borings indicate it is absent on-site. The deeper sand and gravel unit is the major water supply aquifer in the area. The depth to bedrock, which consists of interbedded shales and dolomites, is about 130 feet.

3.2 Site History

American Chemical Services is a solvent recycling and chemical blending facility located in Griffith, Indiana. The company has operated at the location since 1958. Since November 1980, the ACS plant has operated as a hazardous waste facility under the Interim Status Standards of the Resource Conservation and Recovery Act (RCRA).

The ACS solvent recovery process generates still bottom wastes which, between 1958 and 1975 were deposited in one of two surface water lagoons on the site. In the 1960's, leaching and/or runoff from the pond area reportedly caused vegetation kills in the marsh immediately to the west of the site. Operation of the Still Bottoms Pond and one of the Treatment ponds was terminated between 1972 and 1975. Another pond, called the fire pond was constructed in 1973 and still exist on site.

From 1958 to 1975, ACS stored and/or disposed of barrels of waste at two locations. A location on the north central part of the present ACS facility has been labeled the On-Site Containment area, and another termed the Off-Site Contaminant Area was operated as a landfill south of the present facility. In addition, ACS operated two incinerators between 1968 and 1978, incinerating an estimated two million gallons of chemicals per year. In 1980, ACS sold a 31-acre parcel of property west of the second disposal area to the City of Griffith for a landfill.

The Griffith Landfill is an active sanitary landfill operation. Inactive portions were reported to have received hazardous wastes from ACS and Kapica Drum, Inc. prior to RCRA. Kapica Drum, Inc. was a drum reconditioning facility which generated drum residues and rinse water from cleaning drums that contained hazardous wastes. Figure 2 summarizes the interrelationship

between ACS, Kapica Drum, Inc., and the Griffith Landfill based on a review of available information. For a more detailed site history, refer to the ACS Initial Site Evaluation Report (document number 160-WP1-RT-AUJD-1).

U.S. EPA activities concerning the ACS site began in February, 1980 and continue to the present time. During this time, two on-site investigations were conducted in order to develop information necessary for the Hazard Ranking System (HRS). In June 1983, the HRS score for the site were as follows:

1) Groundwater Route Score	59.86
2) Surface Water Route Score	8.89
3) Air Route Score	0.00
4) Overall Average Score	34.98

The ACS was listed on the National Priorities List (NPL). Preliminary Planning Documents were developed for the U.S. EPA by Roy F. Weston Consultants. In 1986, a group of approximately 125 potentially responsible parties (PRPs) appointed a nine member steering committee to organize, oversee and determine funding for the RI/FS. The chairman of the PRP Steering Committee is Andrew Perellis, Esq., of the Chicago law firm Coffield, Ungaretti, Harris and Slavin.

In conjunction with the U.S. EPA and the Steering Committee, Warzyn develop a work scope for Phase I and II of the investigation. The Work Plan was completed by Warzyn in April 1988 and approved by the U.S. EPA. This document contains the final drafts of the Quality Assurance Project Plan (QAPP) and the Sampling and Analysis Plan. A copy of the approved Work Plan is attached as Appendix A. Scheduled completion date for the site specific Health and Safety Plan is May 19, 1989.

3.3 Target Compounds

Previous investigations have detected contaminants in the groundwater, surface water/leachate, and soil at some level. The contaminants encompass a broad spectrum of volatile organics, extractable organics, and heavy metals. The highest reported concentrations of the specific constituents are listed in Tables 1, 2 and 3. The target parameters for sample analysis are listed in Appendix C. Appendix C also lists detection limits for each element or compound.

3.4 Project Objectives

The RI/FS will be performed to gather and assess information needed to accomplish the following objectives:

- Determining if the ACS site poses a risk to public health, welfare, or the environment.
- Determining the characteristics, extent and magnitude of contamination at the site.
- Defining the pathways of contaminant migration from the site.
- Defining on-site physical features and facilities that could affect contaminant migration, containment, or cleanup.
- Developing viable remedial action alternatives.
- Evaluating and screening remedial action alternatives.
- Recommending the cost-effective remedial action alternative which adequately protects health, welfare and the environment.

All tasks, subtasks, and activities are directed toward the accomplishment of these primary objectives.

Under the Superfund Amendments and Reauthorization Act of 1986 (SARA), it is recommended that the RI/FS are integrated so that parts of each are conducted concurrently. Therefore, the project will be conducted in several phases of investigation. Each phase will be designed to make optimal use of information as it is derived and to produce the information which is necessary to complete the FS. A summary of tasks covered by this QAPP and intended data uses is summarized in Table 4.

3.5 Sample Network and Rationale

The activities and subtasks related to the field work are listed below. For a complete itemization of all tasks, see the Work Plan (Appendix A). The project schedule is shown in Figure 3.

Phase I:

- Subtask 1B Survey Site Boundaries
- Subtask 1C Geophysical Survey
- Subtask 1D Surface Water Survey
- Subtask 2A Characterize Flow System
- Subtask 2B Initial Shallow Sampling
- Subtask 3A Waste Characterization

Phase II:

- Subtask 4A Groundwater Characterization
- Subtask 4B Soil Contamination
- Subtask 4C Groundwater Transport Model

Phase III:

- Subtask A Install Wells as Necessary
- Subtask B Collect Additional Samples as Necessary

Specific procedures to be used in sample collection for the various sample matrixes are outlined in the Sampling Plan (Appendix B). A summary of sample numbers and matrices is given in Tables 5 and 6. A summary of sample containers, sample volumes, preservation and shipment methods to be used is given in Table 8. The following section briefly details the investigation tasks to be performed in Phases I and II of the RI. Rationale for each task and sample is provided in the Work Plan (Appendix A). Exact locations of sampling points are plotted on Figures 4-1 through 4-5 in the Work Plan.

Subtask 1B Survey Site Boundaries

Activity 1B.1 Establish Site Grid Boundaries

The grid will be based upon two perpendicular baselines with a maximum grid interval of 100 feet. Elevation data will be collected at selected grid points. Grid locations will be surveyed to ± 1.0 foot using an electronic "total station" instrument, which uses an infrared light source to determine distances. Ground elevations will be obtained to an accuracy of ± 0.1 foot. Elevations will also be obtained using the "total station" system. All "total station" output is received as LED output. The instrument is calibrated on a monthly basis.

Activity 1B.2 Survey Site Boundaries

All boundary surveys will be conducted by a licensed Indiana surveyor. Temporary boundary markers will be installed as necessary in order to easily distinguish individual pieces of property. These boundary markers shall be marked with a sign so they will be easy to locate in heavy vegetation.

Subtask 1C Geophysical Survey

The purpose of the geophysical survey is to locate buried "anomalies" which may be drum disposal areas. The areas to be investigated are: ACS Off-Site Containment Area, ACS On-Site Containment Area, Old Still Bottoms Pond, Treatment Pond No. 1, and the Kapica Drum Draining Area. A test shall be conducted to determine if geophysical surveys using a magnetometer and a Geonics EM-31 (or equivalent) will be feasible. The feasibility is uncertain because of the presence of railroads, powerlines, metal buildings and metal process tanks across and surrounding the site.

Geophysical measurements will be taken on a 25-foot grid interval for both instruments (magnetometer and EM device) since major drum disposal units are being sought. Measurements will be stored in the instrument memory or written into field notes. Background measurements will be made before each survey begins and at four-hour intervals and at the end of each survey. This procedure serves to evaluate natural variation in magnetic intensity, instrument drift, or instrument variation due to sensor orientation.

Measurements for background calibration procedure are to be made at the same location each time. Every tenth measurement will be duplicated as a check on the precision of the instrument.

The magnetometer measures the combined effect of the earth's magnetic and spatial variations. Since the earth's magnetic field varies with space and time, absolute calibration and establishment of standards is not as important as determining the relative differences between grid points. The relative variations represent local and spatial anomalies which could be caused, in this case, by buried barrels.

There will not be a unique interpretation of a given anomaly (i.e. the inverse problem). The success of the geophysical survey is determined largely by the experience of the "practitioner" according to van Ee and McMillion (1988) of the U.S. EPA Environmental Monitoring Systems Laboratory, Las Vegas, Nevada (Appendix D).

Subtask 1D Surface Water Survey

A series of 12 bench marks will be established across the site to serve as reference points for surface water elevation measurements. The bench marks will be referenced to USGS elevations to an accuracy of ± 0.01 foot.

Subtask 2A Characterize Flow System

Activity 2A.1 Monitor ACS Hydraulics

A water budget will be conducted to account for the total water usage within the ACS operation. The total water extracted from on-site wells, or obtained from off-site sources will be compared to the water volume discharged to sewers. A system may be established to monitor the volume of the effluent discharged from plan operations.

Activity 2A.2a Install Leachate Wells

Four leachate sampling wells will be installed in the Griffith Landfill. Wells will intersect the first saturated layer, and will not penetrate the base of the landfill.

Activity 2A.2b Monitor De-Watering Pumpage

A system will be installed to monitor the pumpage from the dewatering activities at the Griffith Landfill excavation. Water that collects in this low area is periodically pumped into a municipal sanitary sewer.

Activity 2A.3 Install Perimeter Monitoring Wells

Six monitoring wells will be installed around the perimeter of the ACS site. The wells will be constructed with 10-foot screens located to intersect the water table. Continuous samples will be obtained from each of these boreholes.

Activity 2A.3a Test Near Surface Hydraulic Properties

Three wells will be selected for aquifer testing (slug test, bail tests, or pump tests) to provide estimates of the upper aquifer hydraulic properties. Criteria to select representative aquifer conditions will include saturated thickness and grain size.

Subtask 2A.4 Install Piezometer Grid

A series of about 40 temporary piezometers will be installed by jetting to provide additional data on the groundwater elevation. Piezometers will be located on approximately a rectangular grid. It is anticipated that water levels will be measured at least twice during the course of Phase I and at least once during Phase II. No water quality samples will be obtained.

Activity 2A.5 Model Groundwater Flow System

Since two aquifers will ultimately be analyzed, it is anticipated that the USGS Three-Dimensional Groundwater Flow Model (Modflow) will be used. The model can simulate stresses to the aquifer(s) by actions such as: flow from external sources, flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through river beds. At this point in the investigation, the modeling effort will be limited to the upper aquifer system.

Subtask 2B Initial Shallow Sampling

Activity 2B.1 Effluent Sampling

It is anticipated that four samples of the effluent waste streams will be collected using a timed sampling device or a device activated by portable detection equipment, such as pH meters or Organic Vapor Analyzers (OVAs).

Activity 2B.2 Groundwater Sampling for the Perimeter Wells and Leachate Wells

A water sample will be obtained from each of the six perimeter wells, and four leachate wells. Additional samples from two perimeter wells and the leachate well samples will not be filtered prior to analysis for metals and cyanide.

Activity 2B.3 Surface Water and Sediment Sampling

Eleven samples of surface water and sediments will be collected. Sampling will proceed from the furthest downstream location to the furthest upstream location, as applicable, to minimize contamination from sediments disturbed in the sampling process. The water sample will be obtained first at a given location for the same reasons.

Subtask 3A Waste Characterization

Activity 3A.1 Soil Borings, Test Pits and Surface Soil Sampling

The source characterization activities include surface soil sampling, drilling of 14 soil and waste borings and excavation of six waste pits. Chemical analysis will be performed on 48 investigative samples.

Subtask 4A Groundwater Characterization

Activity 4A.1 and 4A.2 Well Installation and Aquifer Testing

It is anticipated to at least eight, and up to 12 new monitoring wells will be installed. Four wells will be completed in the upper portion of the lower aquifer and at least four wells (up to eight) will be installed in the lower portion of the shallow aquifer. The location and number of wells will be determined based on the results of Tasks 2 and 3. Slug tests will be performed on the four lower aquifer wells and four of the new upper aquifer wells. If indicated, a pump test might be performed.

Activity 4A.3 On-Site Well Sampling and Private Well Sampling

A water sample will be obtained from all of the on-site wells (up to 18 wells total) and ten private water supply wells. All private well samples and up to five additional on-site well samples will not be filtered prior to analysis for metals and cyanide. Another round of sampling of on-site wells is anticipated with up to 9 wells being sampled for the complete TCL and the remaining being sampled for a reduced parameter list approved by the U.S. EPA.

Subtask 4B Soil Contamination

Based on the results of work conducted in Task 3, it is anticipated that additional drilling and sampling will be conducted. Up to 20 samples may be collected for analysis of those compounds detected at each location in Phase I sampling.

Subtask 4C Groundwater Transport Model

The flow model developed under Activity 2A.5 may be expanded to include the lower aquifer and contaminant transport. If modeling is conducted, the proposed model and associated assumptions will be submitted to the U.S. EPA for review and approval.

3.6 SCHEDULE

A schedule of activities of deliverables for the ACS RI is presented in Figure 3. The final RI report should be complete within 12 months after the project begins.

Technical memoranda will be produced and submitted to the Agency at the end of the Phase I investigation. The memoranda will detail field procedures and field methods used to conduct each task and will present the analytical results and other site data. A Pre-Phase II meeting will be held among representatives of the U.S. EPA, the PRP technical sub-committee, and Warzyn to refine the scope of work to be conducted for Phase II.

A separate Phase II Work Plan Addendum and QAPP Addendum will be produced for the refined Phase II scope of work. If additional phases of work are found to be necessary, a similar procedures will be followed for each.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

4.1 OVERALL RESPONSIBILITY

Authorized PRP Representatives

- Andrew Perellis, Esq.
ACS Steering Committee
- Barbara Magel, Esq.
ACS Steering Committee

PRP Project Coordinator

- Joseph D. Adams, Jr., PE
Warzyn Engineering, Inc.

Principle Investigator

- Peter Vagt, Ph.D.
Warzyn Engineering Inc.

U.S. EPA Remedial Project Manager

- Robert Swale
U.S. EPA, Region V
- RI/FS Reports and technical memoranda prepared
by Warzyn Engineering Inc.

4.2 MONITORING AND SAMPLING OPERATIONS AND QC

- Principal Engineering Firm - Warzyn Engineering Inc.
- Drilling - to be determined through bidding process.
- Geophysics - to be determined through bidding process.
- Sampling, Monitoring and Survey - Warzyn Engineering Inc.
- Quality Control
- Richard W. Maurer, Warzyn Engineering Inc.
(Quality Assurance Officer or his designate)

4.3 LABORATORY ANALYSES AND QC

- Analysis of groundwater, soils and leachate samples for Target Compound List (TCL) organics (see Appendix B for analyte list) using Contract Laboratory Program (CLP) protocols:
 - Hazleton Laboratory
3301 Kinsman Blvd.
Madison WI 53704

or

- Compuchem
3308 Chappel Hill Rd/Nelson Hwy
Research Triangle Park, North Carolina 27709
- Analysis of groundwater, soils and leachate samples for Target Compound List (TCL) organics using protocols for low detection limit analyses (see Appendix C for method description):
 - Hazleton Laboratory
3301 Kinsman Blvd.
Madison WI 53704
- Analysis of groundwater and leachate samples for Target Analyte List (TAL) inorganics (see Appendix D for analyte list) and general water quality indicator parameters including COD, TOC, total suspended solids, total dissolved solids, nitrate + nitrite, alkalinity, chloride, sulfate and ammonia-N. Analysis of private well samples for TAL inorganics using low detection limit methods.
 - Warzyn Engineering Inc.
One Science Court
Madison, WI 53711
- Analyses of soil samples collected during activities 2A.3, 4A.1, 4A.2 will be evaluated for Atterburg limits, grain size, permeability and moisture content, and cation exchange capacity.
 - Warzyn Engineering Inc.
One Science Court
Madison, WI 53711

4.4 SPECIALIZED RESPONSIBILITY FOR LABORATORY ANALYSES

- Hazleton Laboratory Data
 - Analytical protocol specified - Warzyn Engineering Inc.
 - Review of analytical protocol - Hazleton
 - Review of analytical protocol - U.S. EPA Region V Quality Assurance Section (QAS) and Central Regional Laboratory (CRL), Contract Program Management Section (CPMS)
 - Internal QA/QC - Hazleton staff
 - Final data review and validation - Warzyn Engineering Inc.
 - Review of tentatively identified compounds and assessment of need for confirmation - Warzyn Engineering Inc.
- Compuchem Data
 - Analytical protocol specified - Warzyn Engineering Inc.
 - Review of analytical protocol - Compuchem

- Review of analytical protocol - U.S. EPA Region V Quality Assurance Section (QAS) and Central Regional Laboratory (CRL), Contract Program Management Section (CPMS)
 - Internal QA/QC - Compuchem
 - Final data review and validation - Warzyn Engineering Inc.
 - Review of tentatively identified compounds and assessment of need for confirmation - Warzyn Engineering Inc.
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- Warzyn Data
 - Review of analytical specifications - U.S. EPA Region V QAS and CRL, CPMS
 - Internal QA/QC - Warzyn Engineering Inc.
 - Final Data review and validation - Warzyn Engineering Inc.

4.5 QUALITY ASSURANCE

- Overall QA Responsibility
 - Warzyn Quality Assurance Officer
- QA for Warzyn Subcontracted Activities
 - Warzyn Engineering Inc.
- Review of QAPP
 - U.S. EPA Region V QAS and CPMS, CRL
- Field Analyses
 - Warzyn Engineering Inc.

4.6 PERFORMANCE AND SYSTEMS AUDITS

- Field Operations
 - QAO, Warzyn Engineering Inc.
 - U.S. EPA Oversight Contractor
- Analytical Laboratories
 - U.S. EPA Region V Central Regional Laboratory (CRL)
- Final Evidence File Audits
 - QAO, Warzyn Engineering Inc.

An organizational chart is shown in Figure 4.

5.0 QUALITY ASSURANCE OBJECTIVES

The overall quality assurance objectives are to implement field sampling, chain-of-custody, and quality control reporting procedures that will provide legally defensible data from laboratory analyses in a court of law. Field analyses, including screening of samples for VOCs with an HNu and non-intrusive geophysical measurements, are being made primarily to aid in site selection for more detailed observations and analyses. Quality control objectives for these data, as well as those collected for health and safety purposes, are to obtain reproducible data consistent with limitations imposed by measurement methods used.

Specific procedures to be used for sampling, chain-of-custody, calibration, laboratory analyses, data reporting, internal quality control, audits, preventative maintenance, and corrective actions are described in other sections of this QAPP. This section (5.0) defines goals for the QC effort (accuracy, precision, and sensitivity of analyses and completeness, representativeness, and comparability) for data from analytical laboratories and presents quality control objectives for field measurements. A summary of data collection activities and associated data quality objectives is given in Table 4.

5.1 LEVEL OF QUALITY CONTROL EFFORT

5.1.1 Field Sampling Program

The quality of data from the field sampling program for laboratory analyses will be evaluated through the collection of field duplicates, field and trip blanks. Duplicates will be used to assess the combined effects of sample collection, handling and analysis on data precision. The general level of effort for all matrices will be one field duplicate per 10 investigative samples. Where appropriate, field blanks will be collected at a frequency of one per group of 10 or fewer samples per sample matrix per day. Blank samples will serve to check for procedural contamination or ambient conditions at the site that may result in apparent contamination of samples. Field blanks for leachate and groundwater samples will consist of deionized water passed through decontaminated sampling equipment. Field blanks for groundwater samples requiring filtration (TCL inorganics and indicator parameters) will consist of deionized water passed through a decontaminated filtering apparatus.

A trip blank (consisting of two 40 ml VOA vials filled with DI water and preservative) will be included with each shipment of samples for volatile analysis. The purpose of a trip blank is to assess cross contamination in the shipment cooler of samples targeted for volatile organic analysis. Trip blanks will not be analyzed unless the field blank shows contamination. The trip blank will not be opened, but remain sealed from the time it is taken from the laboratory. A shipment is to be considered a shipping unit, i.e. a single cooler.

5.1.2 Laboratory Analysis

Hazleton

Analysis of groundwater, soils and leachate samples for Target Compound List (TCL) organics (see Appendix C for analyte list) will be performed either by Hazleton or Compuchem using Contract Laboratory Program (CLP) protocols. Levels of QC effort for these analyses are described in CLP statement of work SOW-7/87 or most recent. Additional volume of sample will be collected for matrix spike/matrix spike duplicate analyses at a frequency of one per twenty investigative samples.

Samples collected from private wells will be analyzed for TCL organics using methods described in Appendix E, which provide lower detection limits than CLP protocols. Larger volumes of sample media and MS/MSD samples will be collected for low-detection-limit analyses (Table 8). As described in the method description, these analyses will have a similar level of QC effort as CLP protocols.

Compuchem

Analysis of groundwater, soils and leachate samples for Target Compound List (TCL) organics (see Appendix C for analyte list) will be performed either by Hazleton or Compuchem using Contract Laboratory Program (CLP) protocols. Levels of QC effort for these analyses are described in CLP statement of work SOW-7/87 or most recent. Additional volume of sample will be collected for matrix spike/matrix spike duplicate analyses at a frequency of one per twenty investigative samples.

Warzyn

Analyses for Target Analyte List (TAL) inorganics and general water quality indicator parameters will be performed by Warzyn using methods specified in Appendix F. QC analyses include matrix spike, laboratory duplicate and blank analyses at frequencies summarized in Appendix F. Samples from private wells for TAL inorganics analysis will be analyzed using methods providing lower detection limits. These methods and associated levels of QC effort are also specified in Appendix F.

Physical analyses, including Atterburg limits, grain size, moisture content and permeability, will be performed by Warzyn. Methods to be used are summarized in Appendix F. Level of QC effort will be limited to duplicate analyses.

5.1.3 Field Measurements

pH

Level of QC effort for field measurement of pH will consist of precalibration using two buffer solutions and calibration verification at regular intervals (at least every ten samples), as outlined in Appendix G.

Specific Conductance

Level of QC effort for specific conductance measurements will consist of initial and continuing calibration verification (at least every ten samples) using a standard solution of known conductivity, as outlined in Appendix H.

Geophysical Measurements

Test surveys will be conducted using a magnetometer and a Geonics EM-31 or equivalent instrument. These test surveys will be used to determine if usable data can be obtained in spite of the expected interferences from man-made structures. The instruments will be calibrated according to manufacturer's instructions. In addition, background calibration measurements will be made at the same location prior to each survey, after each four hours of traverse, and at the end of each survey.

This procedure will provide the data replication and verification to evaluate natural variations in the magnetic intensity, instrument drift, and/or variations due to sensor orientation. Duplicate readings will be made every tenth grid location as a check on the instrument precision. Absolute values of the field intensity are not as important as determining the relative differences between grid locations, since the purpose of the survey is to locate buried anomalies.

Water Elevation

Water elevations will be measured using an electronic water level indicator or sounding device and fiberglass tape. Both devices make an audible sound in contact with liquid and will be used as a basis for measuring depth to groundwater. Quality control effort will be limited to averaging repeated measures at each measurement location.

Air Monitoring

Level of QC effort for air monitoring and sample screening for the photoionization meter (HNU PI-101) and the Monitox unit will be limited to daily calibration. Method of calibration for both instruments are specified in Appendices I and O.

5.2 ACCURACY, PRECISION AND SENSITIVITY OF ANALYSES

The QA objectives of analyses with respect to accuracy, precision and sensitivity are to achieve acceptable data based on specified performance criteria. Accuracy and precision requirements and method detection limits for CLP based analyses are described in CLP Statement of Work SOW 7/87, or most recent. These criteria also apply to low-level TCL analyses to be performed on samples derived from private wells.

Accuracy and precision definitions for TAL inorganics analyses, general water quality analyses and physical analyses are summarized in table form with methods descriptions in Appendix F. Precision of laboratory analyses is judged from results obtained from laboratory duplicate analyses. A method specific, minimum relative percent difference (RPD), (see Section 14 for definition) is listed in Appendix F, which will be used for assessing data quality. Data accuracy will be assessed based on results of U.S. EPA QC reference samples and those of matrix spike analyses. Limits for the former are provided with the sample. Minimum percent recovery (see Section 14 for definition) is specified in Appendix F.

In addition to laboratory QC samples, field QC samples will also be collected. These will include both duplicate and blank samples. Variability in duplicate samples will reflect combined effects of both sampling and analytical error. No project specific maximum RPD has been set for duplicate samples. Blank samples will be used to test for any cross contamination associated with sampling activities. Again, no project specific maximum for results of blank samples has been established.

Accuracy of field measured pH will be judged from agreement of instrument readings with standard buffer solutions. Agreement with standards will be within 5% of expected value and field measurements will be made to 0.01 unit. Measurement precision will be estimated by periodically (1 per 10 samples) making duplicate readings of samples. If the unit fails to calibrate it will be replaced.

Accuracy of the conductivity meter will be assured by daily calibration verification with a check standard. If readings vary more than 5% from expected values, the unit will be replaced.

Data needs for geophysical measurements require the ability to detect differences on a consistent relative scale. Hence, in most cases an absolute calibration is not required. However, where applicable, instruments will be calibrated prior to use or be checked using manufacturer's suggested test procedures to assure proper and consistent operation.

Accuracy of field instruments (HNU, Monitox) used for sample screening and health and safety purposes will be assured by daily calibration. If units fail to calibrate, they will be replaced.

5.3 COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

Completeness is defined as the proportion of data collected that meet project specific acceptance criteria. It is anticipated that at least 95% of the data collected will meet acceptance criteria. If required performance criteria are not met by performing laboratories, they will reanalyze samples if holding times permit. If holding times are exceeded, the performing laboratory will inform the Warzyn project manager as soon as possible, so that a decision can be made to resample or to accept the data with limitations can be made. Method of calculation is discussed in Section 14.

Sampling, preservation and analysis methods are designed to provide analysis results that are representative of the sample matrix at the point of collected. We recognize the potential for considerable spatial heterogeneity in parameters measured at the site. Hence, the degree to which the sampled locations represents the population of all potential sampling points cannot be stated precisely. Consequently, no quantitative expression of representativeness is proposed.

The analysis method used are expected to provide data of comparable or greater quality with that previously collected and that which may be collected in subsequent project phases. Although data proposed for collected are judged to be of acceptable comparability, no quantitative expression of comparability is proposed.

6.0 SAMPLING PROCEDURES

Specific sampling procedures to be used are documented in the Sampling Plan (Appendix B). Containers, preservatives, holding times, transport and storage methods are summarized in Table 8 of the QAPP and Table 3 of the Sampling Plan.

Documentation of use of specific procedures in the Sampling Plan will be made by initialed entries in the field logs book by the sampling team leader. These shall include, but not be limited to, such operations as decontamination of sampling equipment between sampling locations.

7.0 SAMPLE CUSTODY AND DOCUMENTATION

Field

Sample documentation for field samples will follow chain-of-custody procedures including the use of chain-of-custody forms, sample container tags, custody seals, sample identification records and field notebooks. All samples will be collected under chain-of-custody procedures. The latter will include sampling time, location, tag numbers, samplers, pertinent PID readings, weather conditions, and any field modifications of sampling strategy. Standard forms including chain-of-custody record forms, sample labels, sample identification record forms, and chain-of-custody seals will be maintained throughout the RI/FS sampling activities.

A copy of the chain-of-custody form to be used is shown in Figure 5. Form requirements:

- One form per shipping container
- Carrier service does not need to sign form if custody seals remain intact during shipment.
- Use for all samples.

An example of the chain-of-custody seal to be used for sample shipping is shown in Figure 6. Seal requirements:

- Two (2) chain-of-custody seals per shipping container attached to the cooler lid to provide evidence that samples within have not been tampered with.
- Cover seals with clear tape prior to shipping sample containers.
- Record chain-of-custody seal numbers on chain-of-custody forms as well as sample identification record forms.

A copy of the sample label to be used is shown in Figure 7. Label requirements:

- Each sample container must have a sample label affixed to it. Label will specify sample date, parameters for analysis and preservative used.
- Record sample label numbers on the chain-of-custody form and sample identification record form.
- Use for all samples.

An example of the Sample Identification Record Form to be used is shown in Figure 8. The form is to provide the means of recording shipping and tracking information. The form will include information such as:

- Sample number
- Sample matrix
- Sample location code
- Sample round
- Chain-of-custody number
- Lab code
- Date sampled
- Date shipped
- Airbill number
- Sample label number

The documentation accompanying the samples shipped to the laboratory will be sealed in a plastic bag taped to the inside of the cooler lid. The lid of the sample cooler will be securely taped shut prior to shipment. Once in the laboratory's possession, sample custody will be the responsibility of the laboratory sample custodian.

Original field notes and field documents will be maintained by Warzyn in a final evidence file. Original deliverables for analyses performed by Hazleton and Warzyn will also be contained in this file. Format and maintenance of the Warzyn's final evidence file are given in Appendix I.

Laboratory - Hazleton

Internal chain-of-custody procedures for Hazleton Laboratories and Compuchem will follow those described for their respective laboratories in Appendix L.

Laboratory - Warzyn

Internal chain-of-custody procedures for Warzyn's laboratory are as follows. Samples are delivered to Warzyn's laboratory under chain-of-custody. A designated sample custodian accepts custody of the shipped samples and verifies that the chain-of-custody seals have not been broken. The sample custodian reviews the information on the sample tags/labels with that on the chain of custody records. Pertinent information as to shipment, pickup, courier, etc., is entered in the remarks section. The custodian then enters that sample tag/label data into a bound logbook which is arranged by project code and station number. The sample custodian must acknowledge receipt on the chain-of-custody form. Any comments pertaining to the shipment should be made under "Remarks".

The sample custodian will use the sample tag/label as identification information to assign a unique sequential laboratory number to each sample. This laboratory number is entered on the chain-of-custody form. The information is logged on to the laboratory logbook. The sample custodian will transfer samples to the proper analyst or store the sample in the appropriate refrigerator. The chain-of-custody and testing request forms are forwarded to the laboratory supervisor.

The laboratory is a secured area with strict limited access. Data files and doors are locked daily. Laboratory personnel are responsible for the care and custody of samples from the time they are received until the sample is returned to the custodian or refrigerated.

When sample analyses and necessary quality assurance checks have been completed by the laboratory and sample holding times are exceeded, the unused portion of the sample will be disposed of properly. Identifying tags, data sheets, and laboratory records shall be retained as part of the permanent documentation of the project and forwarded to the Warzyn Engineering Inc. Project Coordinator for inclusion in the evidentiary file.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

Field Calibration

Calibration of pH and specific conductance meters are detailed in Appendices G and H, respectively. Standard solutions will be used to calibrate the instruments at least every ten samples.

Calibration of the HNu PI-10 (photoionization meter), will follow procedures recommended by the manufacturer (see Appendix I). The HNu will be calibrated to read in benzene equivalents at the beginning of each working day using calibration gas (isobutylene) supplied by HNu.

Calibration of the Organic Vapor Analyzer (OVA) will follow the procedures outlined in Appendix J at the beginning of each day of use.

HCN Monotox detectors will be checked for accuracy each working day prior to use (Appendix O). If the detector fails to calibrate, it will be replaced.

Instruments used for geophysical survey will be calibrated or will undergo internal systems checks, as appropriate, prior to use using methods recommended by the manufacturer. Background calibration measurements will be made prior to each survey, after four hours, and at the end of each survey. These measurements will be made at the same location to provide "closed loops" of data values.

Laboratory Calibration

Procedures and frequency of calibration of laboratory instruments are detailed in Appendices E, F, and the CLP Statement of Work SOW 7/87 (most recent version.)

9.0 ANALYTICAL SERVICES

9.1 HAZLETON

9.1.1 Analytical and Calibration Procedures

Samples analyzed by Hazleton for TCL volatiles, semi-volatiles, and pesticides (see Appendix C for analyte list) will follow CLP protocols outlined in the CLP Statement of Work SOW 7/87 (or most recent version). Samples from private water supply wells analyzed by Hazleton for organic parameters will follow the procedures outlined in Appendix E for analysis and calibration.

9.2 WARZYN

9.2.1 Analytical and Calibration Procedures

Samples analyzed by Warzyn for TCL inorganic parameters (see Appendix C for analyte list) will follow the CLP protocols outlined in the CLP Statement of Work SOW 7/87 (or most recent version).

Samples analyzed by Warzyn for indicator parameters will follow the procedures outlined in Appendix F.

Samples analyzed by Warzyn from private wells for inorganic parameters will follow the procedures outlined in Appendix F.

Samples for geotechnical analysis analyzed by Warzyn will follow the procedures outlined in Appendix F.

10.0 INTERNAL QUALITY CONTROL CHECK

Internal quality control procedures are an integral part of the analytical methods and are, therefore, discussed in detail in the descriptions of the analytical procedures (CLP Statement of Work SOW-7/87 (or most recent version) and Appendices E and F).

The overall objectives of the internal quality control checks are to verify the established precision, accuracy and integrity of the methodology and to support the technical validity of the data. Where appropriate, internal quality control checks for other than CLP-based analyses will include method blanks, laboratory duplicates, laboratory control spikes, and matrix spike analyses. Required frequency and performance criteria for these analyses are listed with method descriptions in Appendices E, F, and in the CLP SOW-7/87 (or most recent version).

11.0 DATA REDUCTION, VALIDATION AND REPORTING

Hazleton or Compuchem - TCL Organics by CLP Reporting

Specific procedures for the identification, quantification and reporting of sample parameters for EPA TCL organics are covered in the CLP Statement of Work SOW-7/87, or most recent. Validation of data will be performed by Warzyn using Technical Directive Document No. HQ-8410-01, Laboratory Data Validation, Functional Guidelines for Evaluating Organics Analyses, February 1988.

Hazleton - TCL Organics by Specified Protocols (Appendix E)

Specific procedures for identification and quantification are presented with the method description in Appendix E. Results will be reported using the reportables format described in CLP SOW-7/87, or most recent. Data validation will be performed by Warzyn using guidelines in Technical Directive Document No. HQ-8410-01.

Warzyn - Metals, Indicator Parameter and Physical Analyses

Procedures to be used in translating instrument output to concentrations of a target analyte are documented with methods descriptions in Appendix D. Data transfer procedures within the laboratory through release of the data to the user is described in Appendix L.

Data deliverables for metals will follow CLP format as described in Statement of Work SOW 7/87. Data validation will be performed by Warzyn using guidelines provided in Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analyses, November 1985.

Deliverables for general water quality indicator parameters will include raw data, results of calibration standards, duplicates, blanks matrix spikes and performance evaluation samples. The reporting format to be used is unspecified. Data will be validated by Warzyn using performance criteria tabulated in Appendix F for each analyses. If performance criteria are met, data will be considered of acceptable quality. If performance criteria are not met, data will be considered estimated or unusable.

12.0 PERFORMANCE AND SYSTEM AUDITS

External Audits

The Region V CRL will audit performing laboratories as a basis for approval or disapproval of the laboratory for requested analyses. Performance audits are to be made as specified in the appropriate CLP SOW for analyses by CLP protocols. External performance audits for non-CLP analyses are implemented through analysis of EPA quality control reference standards, which are used in the evaluation of data quality.

External audits of field activities may be performed by the EPA Region V RPM and/or an oversight contractor.

Internal Audits

Internal audits of field and laboratory activities are the responsibility of Warzyn. For subcontracted laboratories, audits will be accomplished through the use of blind samples. For laboratories used on a regular basis, these samples will provide a long-term indication of data quality. Internal audits of Warzyn's analytical laboratory will be performed using procedures described in the audit SOP located in Appendix L. The purpose of the internal laboratory audit is to evaluate and document adherence to analytical procedures described in the QAPP.

Internal field audits will be accomplished thorough unannounced site visits. The purpose of the field audit will be to evaluate and document adherence to procedures described in the QAPP. The audit will include field activities, sample tags and chain-of-custody forms, field notebooks and sampling and decontamination methodologies. A description of the audit to be performed is included in Appendix L.

A summary of results of audits will be included in scheduled progress reports.

13.0 PREVENTATIVE MAINTENANCE

Preventative maintenance procedures for field instrumentation are detailed in instrument manuals in Appendices G through J, M, N and O.

Maintenance procedures for laboratory instrumentation and equipment associated with CLP protocols are referenced in the CLP Statement of Work SOW-7/87 (or most recent version). The method descriptions found in Appendices E and F contain preventive maintenance procedures for instrumentation and equipment associated with the laboratory analysis.

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

Assessment of accuracy, precision and completeness for analyses based on CLP protocols will follow specifications stated in the CLP Statement of Work SOW-7/87. Accuracy and precision definitions for analysis of water samples for general water quality and private water supply well parameters are specified in the method descriptions found in Appendices E and F.

Assessment of accuracy, precision and completeness of analytical data is based on the acceptable result of QC samples. Where appropriate these include blanks, duplicate samples, laboratory control spikes and matrix spike duplicates.

Method, field and trip blank results are expected to provide a measured value that is less than or equal to the reported detection limit.

Field and laboratory duplicate sample results are assessed based on relative percent difference (RPD) between values, using the following equation:

$$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100\%$$

D_1 = first sample value

D_2 = second sample value (duplicate)

Laboratory control spikes results are assessed based on the percent recovery (%R) of fortified analytes. Percent recovery is calculated using the following equation:

$$\%R = \frac{Q_d \times 100\%}{Q_a}$$

Q_d = Quantity determined by analysis

Q_a = Quantity added to sample

Matrix spike/matrix spike duplicate data are assessed based on recovery of fortified analytes using the following equation:

$$\text{Matrix Spike Percent Recovery} = \frac{(\text{SSR} - \text{SR})}{\text{SA}} \times 100\%$$

SSR = Spike Sample Results
SR = Sample Result
SA = Spike Added

Relative percent difference (RPD) between the matrix spike and matrix spike duplicate is calculated using the following equation:

$$\text{RPD} = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100\%$$

D₁ = first sample value
D₂ = second sample value (duplicate)

Data completeness is the percentage of data meeting acceptance criteria. It is calculated using the following equation:

$$\text{Completeness} = \frac{N_1}{N_2} \times 100$$

N₁ = Number of Acceptable Observations
N₂ = Total Number of Observations

15.0 CORRECTIVE ACTION

A Quality Control audit will be conducted for the combined Phase I and II data. The U.S. EPA RPM will be notified of the quality control audit results in writing when the audit is complete if there have been delays or if there is less than 95% completeness (including estimated or unusable data). Warzyn and the U.S. EPA QAO will be responsible for developing and initiating corrective actions, which might include:

- Re-analysis of the samples, if holding time criteria permits;
- Resampling and re-analysis;
- Evaluating and amending sampling and analytical procedures; and
- Accepting data, acknowledging level of uncertainty.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Technical memoranda will be produced and submitted to the Agency at the end of the Phase I investigation. The memoranda will detail field procedures and field methods, present site data, and include a quality assurance section. The final RI report will contain separate sections that summarize data quality.

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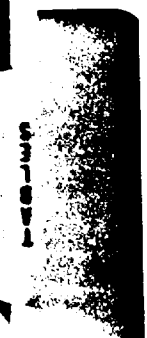


TABLE 1
GROUNDWATER CHARACTERISTICS

<u>Compound</u>	<u>Range (mg/l)</u>
Benzene	<0.005-29 ^{1,2}
Toluene	ND-35 ¹
Vinyl Chloride	<0.005-36 ²
Chloroethane	<0.005-980 ¹
Ethyl benzene	ND-10 ¹
1,2 Transdichloroethylene	<0.005-34 ¹
Methylene Chloride	<0.005-2.2 ²
1,1 Dichloroethane	<0.005-1.3 ²
1,2 Dichloroethane	ND-0.67 ²
1,2 Dichloropropane	ND-0.74 ²
Trichloroethylene	ND-0.039 ²
Phenol	ND-0.75 ¹
2,4 Dimethylphenol	ND-0.14 ¹
bis (2-Chloroethyl) ether	ND-327 ¹
1,1,1-Trichloroethane	<0.005-1.1 ^{1,2}

Notes

- 1 Ecology and Environment Well Sampling Results, November 3, 1982.
- 2 Phase I Report, Preliminary Hydrogeological Assessment, American Chemical Services, Colfax Avenue, Griffith, Indiana, ATEC Associates, 1/15/86.
- 3 ND - Not Detected
mg/l = milligrams per liter

TABLE 2
LEACHATE/SURFACE WATER CHARACTERISTICS

<u>Compound</u>	<u>Range (ug/l)</u>
Naphalene	<0.1 - 29 ¹
Phenol	1.1 - 35 ¹
Diethylphthalate	<0.4 - 10 ¹
Phenenthrene and Anthracene	<1 - 0.1 ¹
Di-n-butylphthalate	0.4 - 21 ¹
bis (2-ethylhexyl) phthalate	5.4 - 510 ¹
bis (2-chloroethyl) ether	<0.1 - 300 ¹
Dimethylphthalate	<0.1 - 2,300 ¹
(2-ethoxy) ethyl acetate	ND - 17,000 ^{1,3}
2-(hydroxymethyl)-1-pentanol	ND - 40,000 ^{1,3}
trimethyl-2-cyclohexen-1-one	ND - 36,000 ^{1,3}
n-methyl-2-pyrrolidone	ND - 11,000 ^{1,3}
1-(2-but oxyethoxy) ethanol	ND - 6,800 ^{1,3}
2-ethylhexanoic acid	ND - 4,100 ^{1,3}
methylphenol (2)	ND - 57,000 ^{1,3}
ethylphenols (3)	ND - 58,000 ^{1,3}
dimethylphenols (3)	ND - 15,000 ^{1,3}
pentylphenol	ND - 4,100 ^{1,3}
methoxytrimethylphenol	ND - 11,000 ^{1,3}
dimethyl benzenedicarboxylate	ND - 5,300 ^{1,3}
2,2,4-Trimethyl-3-cyclohexene	ND - 1,700 ^{1,3}
-1-methanol	
2-(2-methoxy-1-methylethoxy)	
-1-propanol	ND - 500 ^{1,3}
1,1-oxybis-2-chloroethane	ND - 53 ^{1,3}
3,3-5-trimethylcyclohexene	ND - 460 ^{1,3}
Benzene	1650 ^{1,3}
Ethylbenzene	30 ²
Toluene	1340 ²
TOX	5740 ²

TABLE 2 (Continued)
SURFACE WATER/LEACHATE CHARACTERISTICS

<u>Metal/Cyanide</u>	<u>Range (ug/l)</u>
Cadmium	< - 184 ¹
Chromium	<5 - 254 ¹
Nickel	<30 - 544 ¹
Lead	<30 - 282 ¹
Mercury	<0.1 - 0.8 ¹
Cyanide	<5 - 96 ¹

Notes

- 1 Organic Analytical Results for samples collected at American Chemical Services and Griffith Landfill, Griffith Park, Indiana, May 9, 1980, U.S. EPA, CRL, Organic Laboratory section, 6/13.80.
- 2 Letter: ATEC Associates to L. Rundio, May 2, 1986 transmitting results from March 1986 Sampling.
- 3 Tentatively Identified Compounds (TIC)
- 4 ug/l = micrograms per liter

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TABLE 3
SEDIMENT CHARACTERISTICS

<u>Compound</u>	<u>Range¹ (ug/kg)</u>
Phenol	<1400 - 26
Isophorone	<700 - 6.2
Napthalene	21 - 12,000
Flourene	<7,400 - 1,000
Phenanthrene and Anthracene	26 - 1,400
Di-n-butylphthalate	11 - 1,100
bis (2-ethylhexyl) phtholate	71 - 110,000
butylbenzylphthalate	117 - 8,300
methylnaphthalenes	ND - 32,000 ²
dimethylnaphthalenes	ND - 22,000 ²
dipheylenther	ND - 3,800 ²
 Metals/Cyanide	 <u>Range¹ (ug/g)</u>
Cadmium	<0.2
Chromium	8 - 11
Nickel	5 - 9
Lead	14 - 15
Mercury	.036 - .049
Cyanide	<0.3

Notes

ug/kg = micrograms per kilogram
ug/g = micrograms per gram

- 1 Organic Analytical Results from samples collected at American Chemical Services and Griffith Landfill, Griffith Park, Indiana, May 9, 1980. U.S. EPA, CRL, Organic Laboratory Section 6/13/80)
- 2 Tentatively Identified Compounds (TIC)

TABLE 4
SITE INVESTIGATION ACTIVITY SUMMARY

<u>Activity</u>	<u>No.</u>	<u>Type</u>	<u>Description</u>	<u>Result</u>	<u>Utilization of Data</u>	<u>Anticipated Number of Investigative Samples</u>
Establish Grid Boundaries	1B.1	IM	A survey guide will be established for the site	Ground elevation at grid points	1) Location and elevations of sampling points 2) Ground control elevations for remedial activities 3) Ground control for geophysical survey	0
Survey Site Boundaries	1B.2	IM	Survey property boundaries	Establish the locations of property boundaries	1) Define ACS, Griffith Landfill and Kapica Drum (Pazmay Corp) boundaries 2) Identify appropriate parties for site access 3) Identify ownership of property that may be contaminated or contain hazardous waste	0
Geophysical Survey	1C	IM	Feasibility of geophysical techniques will be evaluated. If feasible, a site survey using a applicable method will be performed.	Site diagrams with anomalous areas marked	1) Locate areas of possible drum drum disposal 2) Finalize soil boring and monitoring well locations.	0
Surface Water Survey	1D	IM	Benchmarks will be established at 12 surface water locations on site.	Reference elevations for water level measurements	1) Document the relationship between surface water and groundwater. 2) Determine if marsh areas are discharge areas or recharge sources.	0
Test Near Surface Hydraulic Properties	2A.3a	IM	Permeability testing will be performed at these locations in the upper aquifer.	Estimates of upper aquifer permeability.	1) Data will be used as input to groundwater flow models.	0
Install Piezometer Grid	2A.4	IM	Forty piezometers will be installed in the first saturated unit encountered	Water table elevations	1) Data will be used to input to groundwater flow models	0

TABLE 4 (Continued)
SITE INVESTIGATION ACTIVITY SUMMARY

<u>Activity</u>	<u>No.</u>	<u>Type</u>	<u>Description</u>	<u>Result</u>	<u>Utilization of Data</u>	<u>Anticipated Number of Investigative Samples</u>
Effluent Sampling	2B.1	LA	Four samples of ACS waste stream will be obtained for analysis.	Concentrations of EPA TCL and TAL parameters and selected indicator parameters	1) Evaluate ACS waste stream as a potential source of contamination.	4 LA
Perimeter Well and Leachate Well Sampling	2B.2	LA	Samples will be collected from 6 perimeter wells and 4 leachate head wells.	Concentrations of EPA TCL and TAL parameters and selected indicator parameters	1) Characterize leachate as a potential contaminant source 2) Provide preliminary indication of contamination in the upper aquifer for use in Phase II planning.	10 LA
Surface Water and Sediment Sampling	2B.3	LA	Surface water and sediment will be sampled at 11 locations.	Concentrations of EPA TCL and TAL parameters	1) Determine if surface drainage water or eroding sediments are a potential contaminant migration risk	11 LA
Soil Borings, Test Pits and Surface Soil Sampling	3A.1	LA	Soil samples will be collected from the soil surface and in association with test pits and soil borings.	Concentrations of EPA TCL and TAL parameters	1) Evaluate location and nature of waste disposal at suspected waste disposal locations 2) Estimate extent to which constituents may be migrating into adjacent soils	48 LA
Well Installation and Aquifer Testing	4A.2	LA	Permeability testing will be performed at 4 locations in the upper aquifer and 4 locations in the lower aquifer	Estimates of aquifer permeability in both upper and lower aquifer	1) Input to contaminant transport model	0
On-site well and Private Well Samples	4A.3	LA	Up to 18 groundwater and 10 private wells will be sampled	Concentrations of EPA TCL and TAL parameters and selected indicator parameters	1) Further examine contamination in the upper aquifer 2) Examine for contamination in the lower aquifer 3) Examine for potential contamination of private water supply wells	28 LA

TABLE 4 (Continued)
SITE INVESTIGATION ACTIVITY SUMMARY

<u>Activity</u>	<u>No.</u>	<u>Type</u>	<u>Description</u>	<u>Result</u>	<u>Utilization of Data</u>	<u>Anticipated Number of Investigative Samples</u>
Additional Soil Sampling	48	LA	Up to 20 soil samples are anticipated in Phase II	Concentrations of EPA TCL and TAL parameters.	Evaluate extent of contamination	20 LA

Notes:

IM = In-Situ Measurement
LA = Laboratory Analysis

TABLE 5
SUMMARY OF PHASE I SOURCE CHARACTERIZATION
SAMPLING AND ANALYSIS PROGRAM

<u>Sample Matrix¹</u>	<u>Laboratory</u>	<u>Laboratory Parameters²</u>	<u>No. of Investigative Samples</u>	<u>No. of Field Duplicates</u>	<u>No. of Matrix Spike/³ Matrix Spike Duplicates</u>	<u>Total No. of Samples</u>
Waste Pits	Hazleton	TCL Volatiles	6	1	1	8
	Hazleton	TCL Semi-Volatiles	6	1	1	8
	Hazleton	TCL PCB/Pesticides	6	1	1	8
	Warzyn	TCL Metals	6	1	0	7
	Warzyn	Cyanide	6	1	0	7
Natural Soils -Waste Pit	Hazleton	TCL Volatiles	6	1	0	7
	Hazleton	TCL Semi-Volatiles	6	1	0	7
	Hazleton	TCL PCB/Pesticides	6	1	0	7
	Warzyn	TCL metals	6	1	0	7
	Warzyn	Cyanide	6	1	0	7
Waste Borings	Warzyn	Volatile Residue	6	1	0	7
	Hazleton	TCL Volatiles	8	1	0	9
	Hazleton	TCL Semi-Volatiles	8	1	0	9
	Hazleton	TCL PCB/Pesticides	8	1	0	9
	Warzyn	TCL Metals	8	1	0	9
Natural Soils -Waste Borings	Warzyn	Cyanide	8	1	0	9
	Hazleton	TCL Volatiles	8	1	1	10
	Hazleton	TCL Semi-Volatiles	8	1	1	10
	Hazleton	TCL PCB/Pesticides	8	1	1	10
	Warzyn	TCL Metals	8	1	0	9
Soil Areas	Warzyn	Cyanide	8	1	0	9
	Warzyn	Volatile Residue	8	1	0	9
	Hazleton	TCL Volatiles	8	1	1	10
	Hazleton	TCL Semi-Volatiles	8	1	1	10
	Hazleton	TCL PCB/Pesticides	8	1	1	10
Soil Borings	Warzyn	TCL Metals	8	1	0	9
	Warzyn	Cyanide	8	1	0	9
	Hazleton	TCL Volatiles	12	2	0	14
	Hazleton	TCL Semi-Volatiles	12	2	0	14
	Hazleton	TCL PCB/Pesticides	12	2	0	14
	Warzyn	TCL metals	12	2	0	14
	Warzyn	Cyanide	12	2	0	14

Notes

- 1 Samples will be considered low or medium concentration.
- 2 See Appendix B for TCL Analyte lists - also up to 30 tentatively identified compounds.
- 3 Sample numbers do not reflect the additional volumes required for matrix spike/matrix spike duplicate analysis.
- 4 Field and trip blanks are not required for soil/waste samples.
- 5 Qualitative screening with HMU or OVA will be done for investigative and duplicate samples only.

TABLE 6
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

<u>Sample⁽¹⁾</u> <u>Matrix</u>	<u>Laboratory</u>	<u>Laboratory</u> <u>Parameters^(2,5)</u>	<u>Study⁽³⁾</u> <u>Phase</u>	<u>No. of</u> <u>Investigative</u> <u>Samples</u>	<u>No. of Field</u> <u>Duplicates</u>	<u>No. of</u> <u>Field Blanks</u>	<u>Matrix Spike⁽⁴⁾</u> <u>Matrix Spike</u> <u>Duplicate</u>	<u>Total No. of</u> <u>Samples</u>
Groundwater	Hazleton	TCL Volatiles	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Hazleton	TCL Semi-Volatiles	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Hazleton	TCL PCB/Pesticides	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Warzyn	TCL Metals (Dissolved)	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	TCL Metals (Total), TSS	1	2	1	1	0	4
			2A	5	1	1	0	7
			2B	*				*
	Warzyn	Cyanide (Filtered)	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Chloride, Alkalinity, Sulfate	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Ammonia, Nitrate-Nitrite, TOC, COD	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Total Dissolved Solids	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
Surface Water	Hazleton	TCL Volatiles	1	11	2	2	2	17
	Hazleton	TCL Semi-Volatiles	1	11	2	2	2	17
	Hazleton	TCL PCB/Pesticides	1	11	2	2	2	17
	Warzyn	TCL Metals (Total)	1	11	2	2	0	15
	Warzyn	Cyanide (Unfiltered)	1	11	2	2	0	15
	Warzyn	Chloride, Alkalinity, Sulfate	1	11	2	2	0	15
	Warzyn	Ammonia, Nitrate-Nitrite, COD	1	11	2	2	0	15
	Warzyn							
Sediment	Hazleton	TCL Volatiles	1	11	2	2	1	16
	Hazleton	TCL Semi-Volatiles	1	11	2	2	1	16

TABLE 6 (Continued)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Sample(1) Matrix	Laboratory	Laboratory Parameters(2,5)	Study(3) Phase	No. of Investigative Samples	No. of Field Duplicates	No. of Field Blanks	Matrix Spike(4) Matrix Spike Duplicate	Total No. of Samples
Private Wells (Low Detection Limits)	Hazleton	TCL PCB/Pesticides	1	11	2	2	0	15
	Warzyn	TCL Metals	1	11	2	2	0	15
	Warzyn	Cyanide	1	11	2	2	0	15
	Hazleton	TCL Volatiles	2	10	1	1	1	13
	Hazleton	TCL Semi-Volatiles	2	10	1	1	1	13
	Hazleton	TCL PCB/Pesticides	2	10	1	1	1	13
	Warzyn	TCL Metals (Total)	2	10	1	1	0	12
	Warzyn	Cyanide (Unfiltered)	2	10	1	1	0	12
	Warzyn	Chloride, Alkalinity, Sulfate,	2	10	1	1	0	12
	Warzyn	Ammonia, Nitrate-Nitrite, COD	2	10	1	1	0	12
Leachate Wells	Hazleton	TCL Volatiles	1	4	1	1	1	7
	Hazleton	TCL Semi-Volatiles	1	4	1	1	1	7
	Hazleton	TCL PCB/Pesticides	1	4	1	1	1	7
	Warzyn	TCL Metals (Total)	1	4	1	1	0	6
	Warzyn	Cyanide (Unfiltered)	1	4	1	1	0	6
	Warzyn	Chloride, Alkalinity, Sulfate	1	4	1	1	0	6
	Warzyn	Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	1	0	6
	Warzyn	TDS, TSS	1	4	1	1	0	6
	Hazleton	TCL Volatiles	1	4	1	1	1	7
	Hazleton	TCL Semi-Volatiles	1	4	1	1	1	7
ACS Effluent	Hazleton	TCL PCB/Pesticides	1	4	1	1	1	7
	Warzyn	TCL Metals (Total)	1	4	1	1	0	6
	Warzyn	Cyanide (Unfiltered)	1	4	1	1	0	6
	Warzyn	Chloride, Alkalinity, Sulfate	1	4	1	1	0	6
	Warzyn	Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	1	0	6
	Warzyn	TSS, TDS	1	4	1	1	0	6
	Warzyn	Atterberg limits	1	18	0	0	0	18
	Warzyn	Particle Size	1	18	0	0	0	18
	Warzyn	Coefficient of Permeability	1	18	0	0	0	18
	Warzyn	Cation Exchange Capacity	1	18	0	0	0	18
Geotechnical Samples-Wells	Warzyn	Moisture Content	1	18	0	0	0	18

TABLE 6 (Continued)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Notes

- 1 Samples will be considered low or medium concentration.
- 2 See Appendix B for TCL analyte lists, also up to 30 tentatively identified compounds.
- 3 The star (*) indicates that the number of samples and specific parameters will be determined from Phase 1 and 2A results. Preliminary assessment indicates that up to 9 wells will be sampled for the complete TCL, and the remaining number will be sampled for a reduced parameter list. Also note that Phase 2A sample number is given as the expected maximum.
- 4 Sample numbers do not reflect the additional volume of samples required for matrix spikes and matrix spike duplicate analysis.
- 5 Temperature, pH and specific conductance measurements will be taken in the field for aqueous samples. Qualitative screening with the HHu or OVA will be performed on solid samples.

TABLE 7
SUMMARY OF DATA GENERATING ACTIVITIES
AND ASSOCIATED DATA QUALITY OBJECTIVES
AMERICAN CHEMICAL SERVICES SITE

<u>Activity</u>	<u>No.</u>	<u>Use of Data</u>	<u>Data Quality Objectives</u>
Establish grid boundaries	1B.1	Establish location of sampling points and ground control elevations for geophysical survey and remedial actions	Vertical elevations within ± 0.01 foot Horizontal distances within ± 0.1 foot
Survey Site Boundaries	1B.2	Define property boundaries	Vertical elevations within ± 0.01 foot Horizontal distances within ± 0.1 foot
Geophysical Survey	1C	Aid in determining sampling locations	Obtain consistent relative differences among sampling locations
Surface Water Survey	1D	Examine the relationship between surface and groundwaters	Vertical elevations within ± 0.01 foot Horizontal distances within ± 0.1 foot
Near Surface Hydraulic Properties	2A.3a	Input to flow model	Estimate of permeability to within an order of magnitude of actual
Install piezometer grid	2A.4	Input to flow model	Vertical elevations within ± 0.01 foot Horizontal locations within ± 0.1 foot
Effluent Sampling	2B.1	Evaluate ACS waste streams	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOW 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.
Perimeter and Private Well Sampling	2B.2	Characterize nature of potential source and extent of contamination	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOW 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.
Surface Water and Sediment Sampling	2B.3	Evaluate surface water and sediment as contaminant transport routes	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOW 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.

TABLE 7 (Continued)
SUMMARY OF DATA GENERATING ACTIVITIES
AND ASSOCIATED DATA QUALITY OBJECTIVES
AMERICAN CHEMICAL SERVICES SITE

<u>Activity</u>	<u>No.</u>	<u>Use of Data</u>	<u>Data Quality Objectives</u>
Soil Borings, Test Pits and Surface Soil Sampling	3A.1	Evaluate location and nature of waste disposed of on site	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOM 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.
Well Installation and Aquifer Testing	4A.2	Input to contaminant transport model	Estimate permeability to within an order of magnitude of actual
On-Site Well and Private Well Samples	4A.3	Examine nature and extent of contamination in upper and lower aquifer	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOM 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.
Additional Soil Sampling	4B	Evaluate extent of contamination	Identify compounds present. Meet performance criteria for TCL organics as stated in CLP SOM 7/87 (or most recent). Meet performance criteria for inorganics and indicators as specified in Appendix F.

TABLE 8
SAMPLE QUANTITIES, BOTTLES, PRESERVATIVES AND PACKAGING
FOR WATER, SEDIMENT AND LEACHATE SAMPLES

<u>Analysis</u>	<u>Bottles and Jars</u>	<u>Preservation</u>	<u>Holding Time</u>	<u>Volume of Sample</u>	<u>Shipping</u>	<u>Normal Packaging</u>
WATER AND LEACHATE						
<u>Low Concentration (Organics)</u>						
Semi-Volatiles	Two 1-liter amber bottle (teflon-lined cap)	Iced to 4°C	5 days until extraction, 40 days after extraction	Fill bottle to neck	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
Pesticides/PCBs	Two 1-liter amber bottle (teflon-lined caps)	Iced to 4°C	5 days until extraction, 40 days after extraction	Fill bottle to neck	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
Volatiles	Two (three for private wells) 40-ml volatile organic analysis (VOA vials)	Iced to 4°C HCL to pH <2	7 days (48 hours for surface water)	Fill completely no headspace	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
<u>Low Concentration (Inorganics)</u>						
Metals (groundwater)	One 1-liter high density polyethylene bottle	Filter through 0.45 um filter, HNO ₃ to pH <2 Iced to 4°C Optional	6 months (Hg, 26 days)	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Metals (leachate, surface water and private water supply wells)	One 1-liter high density polyethylene bottle	HNO ₃ to pH <2 Iced to 4°C	28 days	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Cyanide	One 1-liter high density polyethylene bottle	NaOH to pH >12 Iced to 4°C	14 days	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
<u>Other Analysis</u>						
Chlorides, Alkalinity Sulfate	One 1-liter high density polyethylene	Iced to 4°C	28 days (14 days for alkalinity)	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Total Organic Carbon, Ammonia, Nitrate-Nitrite, Chemical Oxygen Demand	One 1-liter polyethylene high density bottle	Iced to 4°C H ₂ SO ₄ to pH <2	28 days	Fill to shoulder	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Total Dissolved Solids Total Suspended Solids	One 1-liter polyethylene high density bottle	Iced to 4°C	7 days (filter upon receipt at lab)	Fill to shoulder	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite

TABLE 8 (Continued)

SOIL/SEDIMENT

Low or Med Concentration (Organics)

Acid extractables, base/neutral extractables, pesticides/PCBs	One 8-oz wide mouth glass jar	Iced to 4°C	10 days until extraction, 40 days after extraction	Fill 3/4 full	Shipped Daily by Overnight Carrier	Foam liner No. 3 (Med in cans/vermiculite)
---	-------------------------------	-------------	--	---------------	------------------------------------	--

Volatiles	Two 120-ml VOA vials	Iced to 4°C	10 days	Fill completely no headspace	Shipped Daily by Overnight Carrier	Vermiculite (Med in cans/vermiculite)
-----------	----------------------	-------------	---------	------------------------------	------------------------------------	---------------------------------------

Low or Med Concentration (Inorganics)

Metals and Cyanide	One 8-oz wide mouth glass jar	Iced to 4°C	6 months (14 days for cyanide)	Fill 3/4 full	Shipped Daily by Overnight Carrier	Foam liner No. 3 (Med in cans/vermiculite)
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Physical Analyses

Grain Size, moisture content	One 8-oz wide mouth glass jar	None	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite
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Atterberg Limits	One 8-oz wide mouth glass jar	None	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite
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Permeability	3-in Shelby Tubes	4°C	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite
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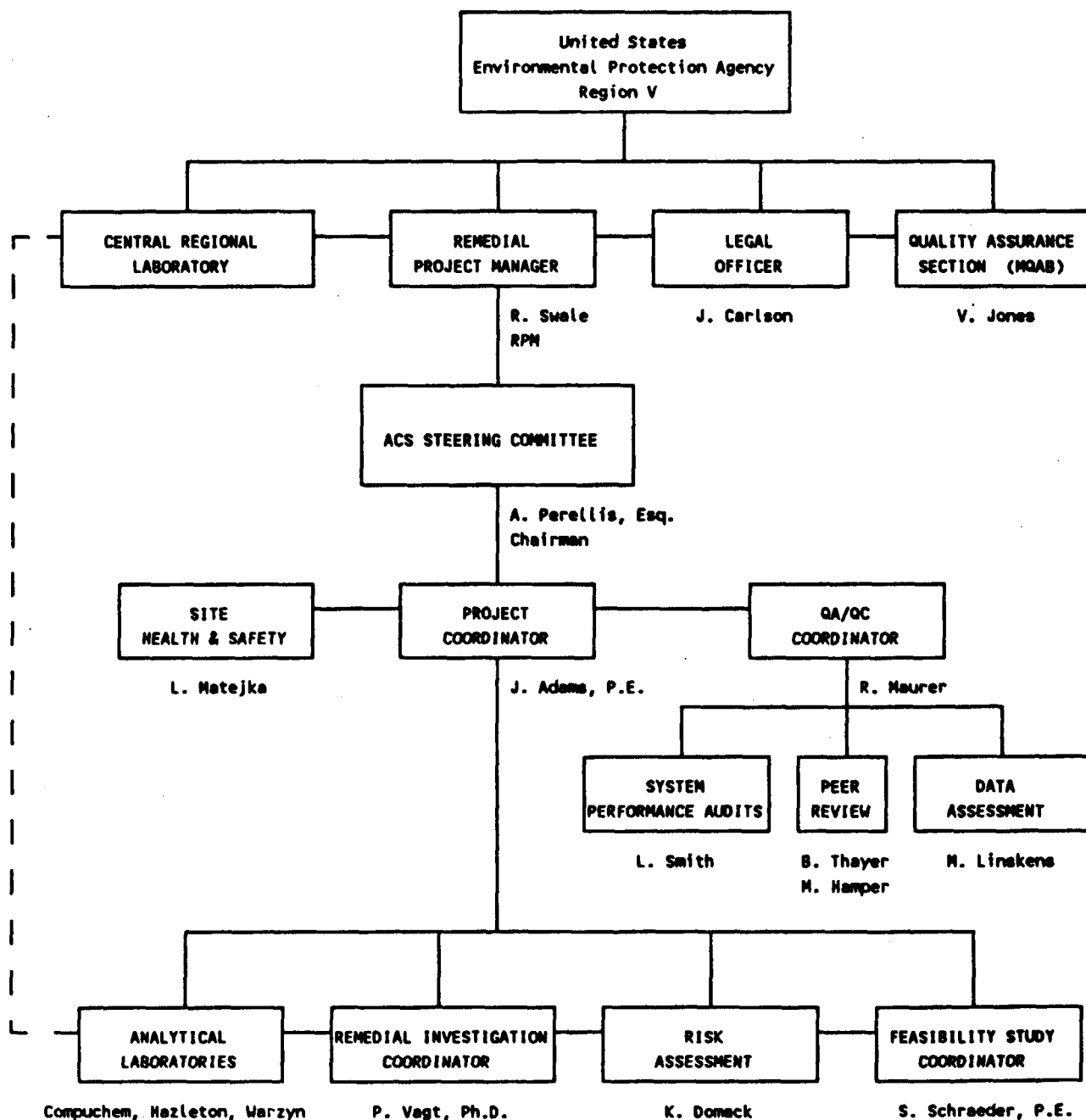


Figure 4. Organizational Chart.

CHAIN OF CUSTODY RECORD

[illegible]

Figure 5. Chain-of-Custody Record



Figure 6. Chain-of-Custody Seal

ANALYTICAL SERVICES

WARZYN
ENGINEERING INC

One Science Court
University Research Park
P.O. Box 5385
Madison, WI 53705
(608) 273-0440

Project # _____ Lab # _____

Sample Name _____

Date Collected _____ By _____

Parameter(s) _____

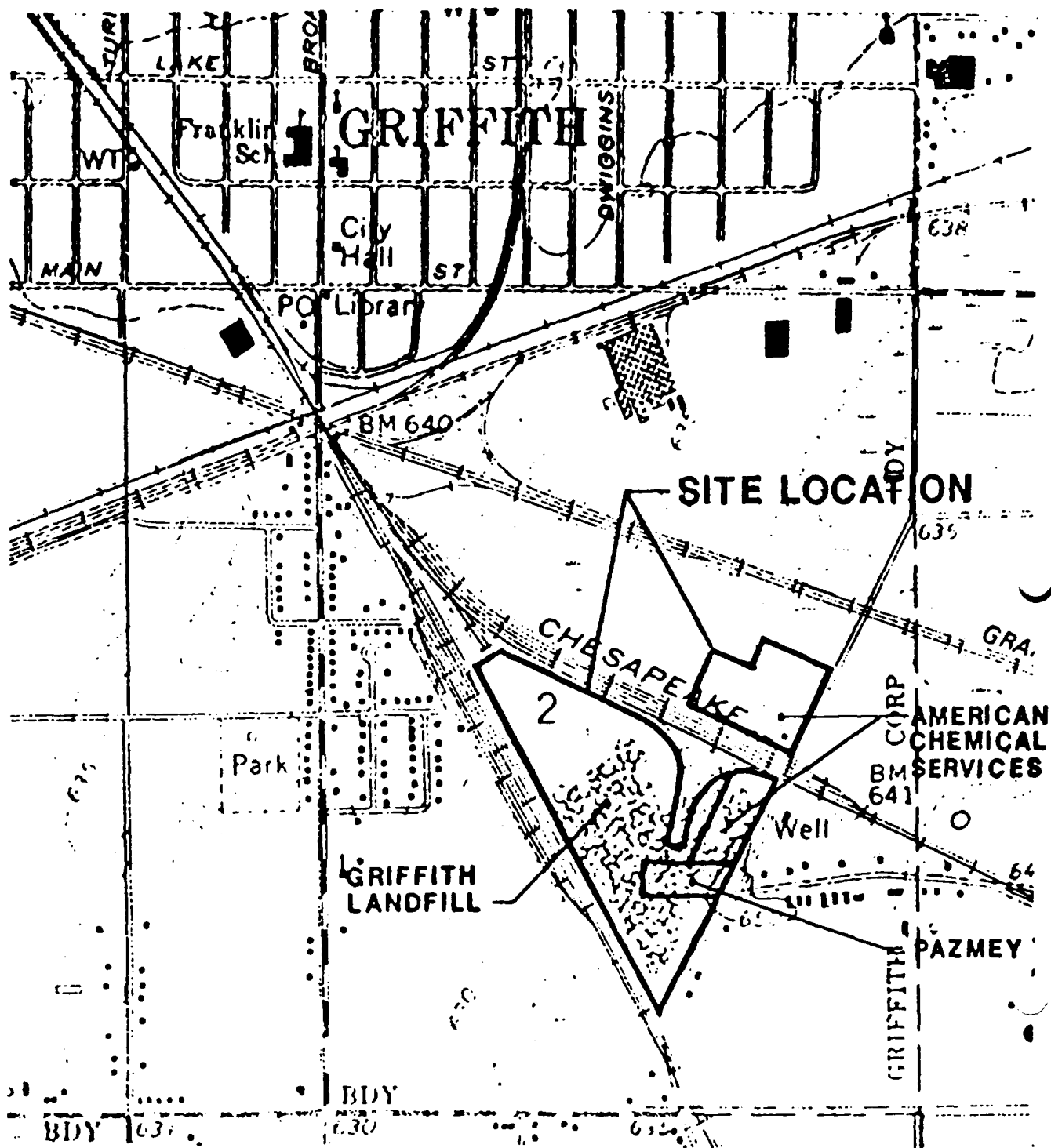
Preservative(s) _____

Figure 7. Sample label

SAMPLE IDENTIFICATION RECORD

[illegible]

Figure 8. Sample Identification Record.



NOTE:

1. SITE LOCATION MAP WAS DEVELOPED FROM U.S.G.S. 7½ MINUTE QUADRANGLE MAP ENTITLED HIGHLAND, INDIANA 1968, PHOTOREVISED 1980.



SCALE: 1"= 1000'

FIGURE 1



SITE LOCATION MAP
RI/FS
AMERICAN CHEMICAL SERVICES SITE
GRIFFITH, INDIANA

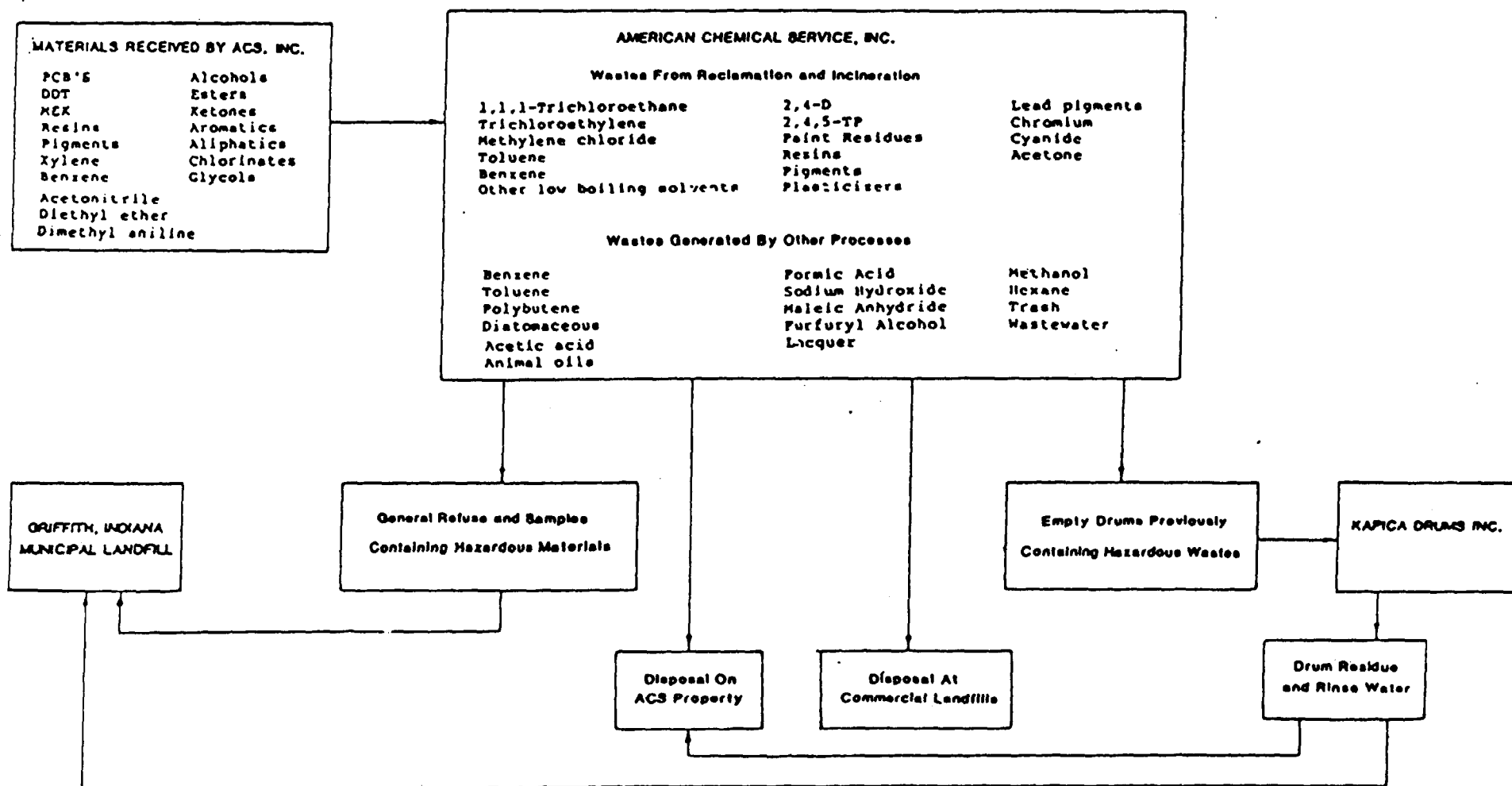


Figure 2. Waste Disposal Flow Chart

APPENDIX A

WORK PLAN

WORK PLAN

AMERICAN CHEMICAL SERVICES, INC.

**TECHNICAL SCOPE OF WORK
APRIL 1988**

**INITIALLY DRAFTED UNDER
EPA WORK ASSIGNMENT NO. 61-5L
REM II DOCUMENT NO. 160-WPI-WP-EBLC-1**

BY:

ROY F. WESTON, INC.

FOR:

**U.S. ENVIRONMENTAL PROTECTION AGENCY
EMERGENCY AND REMEDIAL RESPONSE BRANCH
REGION V
230 SOUTH DEARBORN STREET
CHICAGO, ILLINOIS 60604**

REVISED BY:

**WARZYN ENGINEERING INC.
CHICAGO, ILLINOIS**

REVISED FOR:

**AMERICAN CHEMICAL SERVICES
STEERING COMMITTEE
CHICAGO, ILLINOIS**

APRIL 1988



EXECUTIVE SUMMARY

This Work Plan has been prepared to guide the conduct of the Remedial Investigation/Feasibility Study for the American Chemical Services, Inc. (ACS) site located in Griffith, Indiana. The Pazmey Corporation property (formerly Kapica Drum, Inc.), and the inactive portions of Griffith Landfill property are also included within the total site boundary. Review of existing information revealed references to hazardous wastes being disposed of in Griffith Landfill by ACS. There were also references concerning drum and drum cleaning residues from the operation at Kapica Drum, Inc., being disposed of on ACS property adjacent to the Kapica Drum property and in the Griffith Landfill. It is also likely that drum and drum cleaning residues were disposed of by Kapica Drum, Inc., on its own property.

The Work Plan describes the site background, technical approach to site investigation and feasibility study activities, schedule for project execution, and project staffing for conducting an RI/FS at the ACS site. The objectives of the RI/FS are to conduct a remedial investigation to determine the nature and extent of the release or threatened release of hazardous substances, pollutants or contaminants from the American Chemical Services, Inc. site and to perform a feasibility study to identify and evaluate alternatives for the appropriate extent of remedial action, to prevent or mitigate the migration or release or threatened release, of hazardous substances, pollutants, or contaminants from the American Chemical Services, Inc. facility.

The remedial investigation field work will result in the collection of 68 source characterization samples from the documented and suspected waste burial and soil contamination areas at the site. In addition, 187 site characterization samples (groundwater, surface water, sediment private well and geotechnical) will be collected during the remedial investigation field work.

The feasibility study will include the initial screening of candidate remedial alternatives and subsequent detailed evaluation of selected alternatives. Technical, environmental, economic, and institutional criteria will be utilized to perform the alternative evaluations. A conceptual design and associated cost estimates will be prepared for the recommended remedial strategy.

The estimated time for completion of the RI/FS is 22 months from the date that authorization to proceed is given. This includes 12 months for the remedial investigation and 10 months beyond the end of the RI phase for the completion of the feasibility study.

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SECTION 1
INTRODUCTION

1.1 Site Location and History

The American Chemical Services, Inc. (ACS) site is located at 420 South Colfax Avenue in Griffith, Indiana (Figure 1-1). Although the site name is American Chemical Services, Inc., U.S. EPA has defined the site as including the inactive portion of the Griffith Landfill and the property previously owned by Kapica Drum, Inc. (now owned by Pazmey Corporation) (Figure 1-2). The vast majority of on-site investigative work proposed in the work plan will be on ACS property since it is this property that has a documented hazardous waste disposal history and is on the NPL list. However, review of existing information revealed references to hazardous wastes being disposed of in Griffith Landfill by ACS. There were also references concerning drum and drum cleaning residues from the operation of Kapica Drum, Inc. being disposed of on ACS property adjacent to the Kapica Drum property and in the Griffith Landfill. Kapica Drum Inc. may have disposed of drum and drum cleaning residues on its own property; however, there is no data that substantiates this suspicion.

ACS began operations in May 1955, solely as a solvent recovery firm. Later, the company also began a limited chemical manufacturing operation.

From 1955 to at least 1975, ACS disposed of a variety of hazardous wastes at various locations on its property. The hazardous wastes disposed of on ACS property were primarily from on-site chemical manufacturing and solvent reclamation operations. Some waste was accepted from off-site sources for incineration in the ACS on-site incinerator. The incinerator-generated ash was then disposed of on ACS property.

The Griffith Landfill is still an active sanitary landfill and has been in operation since the 1950's. As stated previously the inactive portion has been included in the Work Plan because it has been reported (Response to U.S. EPA Request for Information sent to ACS-10/18/84) that hazardous wastes from ACS and Kapica Drum, Inc. were disposed of in the landfill prior to the promulgation of RCRA.

Kapica Drum, Inc. had been in operation since 1951. Kapica Drum, Inc. was a drum reconditioning facility which generated drum residues and rinse water from cleaning drums that contained hazardous wastes. Again, as previously stated, it has been included in the Work Plan because it has been reported (response to U.S. EPA Request for Information sent to ACS on 10/18/84) that hazardous waste drum rinse water has been discharged on the ACS and Griffith Landfill property.

Figure 1-3 summarizes the interrelationship between ACS, Kapica Drum, Inc., and the Griffith Landfill based on a review of available information. For a more detailed site history refer to the ACS Initial Site Evaluation Report (document number 160-WP1-RT-AUJD-1).

1.2 Site Status and Project Type

ACS is an active RCRA interim status facility. The 1983 notifier's listing indicates treatment, storage and disposal activities at the site. ACS's EPA I.D. number is IND016360265. The June 1983 Hazard Ranking System scores for this facility were as follows:

1) Groundwater Route Score	59.86
2) Surface Water Route Score	8.89
3) Air Route Score	0
4) Overall Average Score	34.98

This Work Plan is for a Remedial Investigation/Feasibility Study (RI/FS) project.

1.3 Overview

This Work Plan was initially prepared in accordance with the requirements of the Work Plan Memorandum (Document No. 160-WP1-WM-ARLB-1) and Work Assignment (No. 61-5LJ7.0) for the ACS site. The Work Plan was revised by Warzyn Engineering Inc. (Warzyn) for the ACS Steering Committee. General information regarding the site and background data originally presented by Roy E. Weston, Inc. (Weston) was not verified. The objective of this RI/FS is to evaluate the existence and magnitude of contamination and based upon this RI, recommend cost-effective, viable, remedial action alternative(s) for mitigating the hazard posed by the contamination at the site. Specific objectives of the RI/FS include:

- Determining if the ACS site poses a risk to public health, welfare, or the environment.
- Determining the characteristics, extent and magnitude of contamination at the site.
- Defining the pathways of contaminant migration from the site.
- Defining on-site physical features and facilities that could affect contaminant migration, containment, or cleanup.
- Developing viable remedial action alternatives.
- Evaluating and screening remedial action alternatives.
- Recommending the cost-effective remedial action alternative which adequately protects health, welfare and the environment.

This Work Plan presents the site background, technical approach to site investigation and feasibility study activities, schedule for project execution, and project staffing for conducting the RI/FS at the ACS site in Griffith, Indiana.

The first section of the RI/FS Work Plan presents information concerning the location, history, and the status of the ACS site. The second section summarizes the results of the initial site evaluation as reported in the

Initial Site Evaluation Report (Document No. 160-WP-1-RT-AVJD-1). Included in this section are a site description, contamination problem definition, contaminant migration definition, environmental and health effects review, and operable units discussion. The third section describes remedial action alternatives that could be applied at the ACS site and identifies associated data gaps. The fourth section describes the various tasks that will be performed as part of the remedial investigation activity. The fifth section describes the work elements for the feasibility study. The sixth section presents the project schedule.

SECTION 2 INITIAL SITE EVALUATION

The purpose of Section 2 is to summarize the information presented in the Initial Site Evaluation for the American Chemical Services, Inc. site (Document Number 160-WP1-RT-AVJD-1). For detailed discussion and data refer to that document.

2.1 Site Description

2.1.1 Environmental Setting

The American Chemical Services, Inc. (ACS) site is located 1/2 mile southeast of Griffith, Indiana, in the northeast 1/4 of the southeast 1/4, Section 2, Township 35 North, Range 9 West, Lake County, Indiana. The site includes the ACS property (19 acres), the inactive portions of the 31-acre Griffith Landfill on the southwest, and Pazmey Corporation (formerly Kapica Drum, Inc.) on the south (2 acres). The Chesapeake and Ohio Railroad bisects the site. Griffith is located in the Calumet Lacustrine Plain which is characterized by 40 to 250 feet of Wisconsin Age surficial deposits that composed the bed of Glacial Lake Chicago. The Calumet Lacustrine Plain is an area of low relief with three relict shorelines containing dunes (some up to 40 ft high).

Bedrock consists of 4000 feet of Cambrian to Devonian Age limestones, dolomite, sandstones, and shales overlying Pre-Cambrian granitic basement rock. The Detroit River and Traverse Formations, composed of limestone, underlie the Town of Griffith. The sedimentary rocks are gently flexed to form a saddle-like structure as part of the Kankakee Arch. Dip is five to seven feet/mile to the southeast.

Drainage of surface waters in the city of Griffith is to the north and the Little Calumet River is the major drainageway; on the southside of the city of Griffith, drainage is the south toward Turkey Creek. The sediments of the

Calumet Lacustrine Plain are fine lake silts and clays, paludal deposits of muck and peat, and great expanses of beach and dune sand. Sand and gravel deposits also occur in outwash and in till inclusions, and clay-rich tills are also present in the area. The three beach ridges in the area were formed as falling lake levels in Glacial Lake Chicago slightly stabilized after the Valparaiso Moraine was breached. Each beach ridge formation was accompanied by nearshore foredunes.

The topography at the site is almost level in the portion north of the railroad and rises slowly from 630 to 645 feet above MSL in the southern half of the site. Griffith Landfill has excavated about 30 feet of soil to the west of the ACS Off-Site Drum Containment Area near the southeast boundary of the ACS property, thus modifying the gently sloping topography. A marsh to the north of the landfill and west of the ACS property has a surface elevation of about 625 feet. The two major soils in the area are the Plainfield fine sand and the maumee loamy fine sand with average hydraulic conductivities of 1.42×10^{-2} cm/sec.

There are no natural streams in the area of the site, but a marsh does exist immediately to the west of the northern half of the site. Man-made drainage ditches form the western border of the site and eventually enter Turkey Creek one mile to the south. A natural surface water drainage pond is located just to the west of the western boundary of the site, and a fire pond, a pond in which rainwater is collected to be used in case of a fire at the facility, is located about 200 feet to the east. Turkey Creek, a small stream, flows about 1 mile south of the site and the Little Calumet River is located three miles to the north. A copy of the National Wetland Inventory Map for the region is provided as Figure 2-2.

Surficial deposits are 130 feet thick in the vicinity of ACS. They are divided into three units. Unit 1 is a gray and brown sand 10 to 14 feet thick, Unit 2 is a gray clay 10 to 24 feet thick, and Unit 3 is a sand and

gravel layer that extends to bedrock. Bedrock consists of Devonian Limestone. Installation of four shallow groundwater monitoring wells and review of local boring records by the Ecology and Environment, Inc., the U.S. EPA FIT team, confirmed these findings.

Hantke, Hill and Reshkin, (1975) summarized the surficial geology of Lake and Porter counties. Unit 1, was described as medium to coarse silty sand with interbedded beach gravels, and hydraulic conductivity ranging from 2.8×10^{-3} to 4.7×10^{-7} cm/sec. Unit 2 was estimated to have a vertical hydraulic conductivity of 3.3×10^{-7} cm/sec. Unit 3 hydraulic conductivity was estimated to range from 9.4×10^{-3} to 4.7×10^{-2} cm/sec with a storage coefficient of 0.003, indicative of partially confined conditions. Unit 4, a clay unit 15 to 30 feet thick overlying bedrock found regionally was not indicated to be at the site.

At the ACS site, Unit 1 is an unconfined aquifer with a water table that ranges from 3 to 10 feet below the surface. Flow is to the northwest along the Unit 1/Unit 2 contact. Unit 3 is the main aquifer in the area and regional flow in Unit 3 may be to the northeast. (Ecology and Environment, 1980, FIT team report, 1982 and Hantke, Hill and Reshke.) Flow directions at the site in the Unit 3 are not documented.

Although it has been previously stated that groundwater flow is to the northwest at the site in Unit 1, it should be noted that because Turkey Creek flows 1 mile to the south and the Little Calumet River is located three miles to the north of the site, a groundwater flow divide may exist somewhere between the two surface water bodies. Also, due to recent and continued excavations of up to 30 feet of soil from the Griffith Landfill, regional groundwater data may not adequately characterize present conditions at the site.

2.1.2 Site History

A detailed site chronology for the ACS site is included in the ACS Initial Site Evaluation Report (Document No: 160-WP1-RT-AVJD-1). The chronology is divided into the following categories:

- ACS Property Ownership History
- Indiana State Board of Health Site Inspections/Activities and Correspondence Concerning ACS
- U.S. EPA Region V Site Inspections/Activities and Correspondence Concerning ACS
- Correspondence From and To ACS
- Correspondence From the Congress of the United States and Indiana State Legislature Concerning ACS
- Chronology of Newspaper Articles Concerning ACS
- Chronological Summary of ACS On-site Events

The pertinent site history presented in the ACS Initial Site Evaluation Report is summarized in the following paragraphs.

The maximum amount of property that has ever been under American Chemical Services, Inc. control since the company was founded in 1955, is approximately 52 acres. Over the years the amount of property under ACS control has decreased. Two acres of the approximately 39 acre tract south of the C&O railroad were sold to Kapica Drum, Inc. and subsequently resold to Pazmey Corp. An additional 31 acres of the 39 acre tract south of the C&O railroad were sold to the City of Griffith for use as a sanitary landfill. At the present time, American Chemical Services, Inc. owns 6 acres of the original 39 acre tract south of the C&O railroad and approximately 9 acres north of the C&O railroad for a total of approximately 15 acres. In addition, ACS leases 4 acres north of the C&O railroad from the C&O Railway Company.

April 1972 is the earliest documentation of Indiana State Board of Health (ISBH) regulatory activity at the ACS site. Between April, 1972 to September, 1973 the ISBH attempted to achieve improved waste handling, spill prevention measures and site maintenance. ISBH continued involvement with ACS from September 1974 to September 1975 in response to reports that the company was discharging chemicals to the sanitary sewer and dumping chemicals on-site. There was very little ISBH activity concerning ACS during the period September 1975 to December 1982. The first step to list American Chemical Services, Inc. as a NPL site was taken in December 1982 and continued through April 1984 when data was supplied by Techlaw.

U.S. EPA activities concerning the American Chemical Services, Inc. site began in February 1980 and continue to the present. During this period, two on-site investigations were conducted in order to provide information for the Hazard Ranking System. During May of 1980, sampling was conducted at ACS by the U.S. EPA Environmental Emergency and Investigation Branch. Monitoring well installation and sampling was conducted in November 1982 by a U.S. EPA contractor.

2.2 Contamination Problem Definition

2.2.1 Waste Disposed of at Site

Based on available information there are four documented waste burial locations, one suspected waste burial location and four suspected contaminated soil areas. Figure 2-1 shows the locations of each of these areas, and Table 2-1 summarizes the corresponding waste types.

2.2.2 Toxicity of Contaminants

All of the contaminants may have been on the site for ten or more years. Chemical characteristics of the contaminants as they exist now are unknown; therefore, an accurate interpretation of relative toxicity is not possible at

this time. As part of the remedial investigation, an endangerment assessment will be conducted that will address the toxicity of contaminants. The U.S. EPA will provide the necessary information to the Agency for Toxic Substances and Disease Registry (ATSDR) so a Health Assessment may be performed as required by the Superfund Amendments and Reauthorization Act of 1986 (SARA).

2.2.3 Degree of Site Contamination

Documented evidence of the degree of site contamination is limited to the results of two on-site sampling events. During May 1980, samples were collected and analyzed by the U.S. EPA. The results of that analysis revealed organic compounds in the soil and water from a leachate pool near the ACS Off-Site Containment Area. During November 1982, a U.S. EPA contractor installed four monitoring wells on ACS property and collected groundwater samples from the wells. The samples from the two wells near the ACS Off-Site Containment Area contained organic compounds including benzene, toluene, vinyl chloride, pentachlorophenol, ether and chloroethane. Based on this limited information, it appears that site contamination is confirmed near the ACS Off-Site Containment Area. Other areas at the site are also suspected of contaminating the groundwater and soil; however, this cannot be evaluated until the results of the remedial investigation are available.

2.3 Contaminant Migration and Environmental/Health Effects

2.3.1 Migration Pathways

Contaminant migration from the ACS site would most likely be by surface water or groundwater pathways. Airborne contaminant migration is not considered likely from the ACS site. As noted in Section 2.2.3, there is limited documentation concerning contamination of the on-site surface and groundwater. Off site surface water sampling has not been conducted.

Off site groundwater sampling has been conducted on two occasions. The first study was a Lake County Groundwater Survey conducted by the Indiana State Board of Health in 1981. This was a general county survey and was not

conducted in response to the ACS site. The purpose of the survey was to measure total metal content and no organic compound data was collected. Data from seven wells were collected in the vicinity of the ACS site. Well locations ranged from one-half to one-mile southwest of the site. The results of the survey did not reveal any contamination greater than maximum levels set by the Safe Drinking Water Act (SDWA). Since groundwater flow is thought to be in the northeasterly direction, these wells are upgradient from the site and would not be expected to reflect any contamination contributed by the ACS site.

The second groundwater sampling program undertaken by the Lake County Health Department in 1981 consisted of sampling well water from seven homes near the ACS site.

2.3.2 Potential Receptors

Groundwater users are the primary receptor of concern. Surface water users and ecosystems are a secondary receptor. Existing information indicates that there are two aquifers beneath the site that are separated by a clay layer. It has been suggested in the literature that the clay layer is impermeable and continuous; however, this has not been evaluated. Existing information indicates that the majority of the private water wells in the vicinity of the site use the lower (Valparaiso) aquifer as their water source. If the clay layer is continuous, then any contamination would probably be limited to the upper aquifer. In order to investigate the contamination of these groundwater receptors, monitoring wells will be installed during the remedial investigation. In addition, a survey of residential well water quality will be conducted during the remedial investigation.

Surface water in the vicinity of the site is limited to the marsh west of ACS property and a drainage ditch that flows through the marsh. This ditch flows to Turkey Creek which is approximately one mile south of the ACS property. Contamination of these surface waters would be from runoff from the ACS site

or surface leachate from waste disposal sites. Existing records do not indicate any leachate runoff during the past three years. At the present time, there is no surface water quality data available.

2.3.3 Environmental and Public Health Effects

There have been no visible environmental impacts noted since the clay wall was installed around the north end of the ACS Off-Site Containment Area during the early 1980's. Adverse environmental effects or surface leachate were not observed during the initial site visit.

The potential for environmental and public health effects due to surface water contamination is unknown. To date, there are not data available concerning surface water contamination.

The most significant evidence that ACS may threaten local water supply wells was the documentation of low levels of organic contaminants in Test Well #2 located southeast of the Off Site Containment Area. The magnitude of this potential threat to area water supply wells is unknown at this time.

As part of the remedial investigation, an endangerment assessment will be conducted to more accurately define the potential for environmental and public health effects.

2.4 Operable Units

Based on the review of available information and the initial site visit, no operable units have been identified at this time. In the early 1980's a clay containment wall was built around the north end of the ACS Off Site Containment Area where leachate had been observed. During the initial site visit, there was evidence of heavy ground vegetation from the previous growing season at the Off-Site Containment Area. No leachate or any other alarming conditions meriting immediate or fast track measures were observed at the Off-Site Containment Area or at any of the other known disposal sites during the site visit.

During December 1984, the Region V Technical Assistance Team (TAT) conducted a site assessment of the ACS site. Their findings concur that no operable units have been identified at this time. In the TAT report, it was also recommended that other residential wells be sampled and analyzed again. This was done in 1986 by U.S. EPA.

SECTION 3
PRELIMINARY ASSESSMENT OF REMEDIAL ALTERNATIVES

The purpose of this section of the Work Plan is to identify, in a very preliminary way, potential remedial approaches that are consistent with the available site information. This initial identification of potential alternatives was utilized during formulation of the Project Sampling and Analysis Plan so that the data required to ultimately evaluate candidate remedial strategies would be collected. The criteria that will be used to screen and evaluate remedial alternatives are also described. It must be noted that these alternatives have been identified on a preliminary basis based on information currently existing for the site.

3.1 Identification of Remedial Alternatives

Information compiled during the preparation of the Initial Site Evaluation Report indicates that the on-site soils, surface waters, and groundwater are potentially contaminated from past American Chemical Service, Inc., (ACS) and Kapica Drum, Inc., disposal activities and drum reconditioning (i.e., cleaning). Based on the preliminary site characterization data collected to date, possible remedial alternatives listed below have been identified for review and evaluation. It must be noted that because of the paucity of information on the extent and type of buried materials that additional remedial alternatives will be developed during the RI phase.

Remedial Alternative 1

Off-site treatment or disposal of drum material and contaminated soils and sediments

On-site treatment which permanently and significantly reduces the volume, toxicity, or mobility of the hazardous substances, pollutants, and contaminants.

Alternative Component
Technologies

Evaluate available hazardous waste disposal facilities proximal to the site

Remedial Alternative 2

On-site containment

Alternative Component
Technologies

- Native soil cover
- Multilayer cap system
- Synthetic cap system (e.g., liner)
- Slurry Wall
- Grout Curtain
- Sheet Piling

Remedial Alternative 3

On-site disposal of contaminated soil and drum material

Alternative Component
Technologies

On-site encapsulation in a specially engineered cell

Remedial Alternative 4

Groundwater treatment

Alternative Component
Technologies

- Steam or air stripping
- Activated carbon treatment
- UV/ozonation

Remedial Alternative 5

No action

Alternative Component
Technologies

Periodic monitoring

A combination of the above can be identified as additional alternatives, such as:

Remedial Alternative 6

Off site treatment/disposal of contaminated soils/sediments and subsurface environmental isolation

Remedial Alternative 7

Off site treatment/disposal of contaminated soils/sediments, subsurface environmental isolation and treatment of groundwater

Remedial Alternative 8

Isolation/treatment on-site contaminated soil disposal and subsurface environmental isolation

Remedial Alternative 9

Contaminated soil isolation/treatment/ on-site disposal, subsurface environmental isolation and treatment of groundwater

3.2 Performance Criteria and Standards for Remedial Alternatives

Performance criteria will be based on standards that are developed to protect human health and environment at the site. If appropriate, existing standards

such as Maximum Contaminant Levels/Maximum Contaminant Level Goals under the Safe Drinking Water Act, water quality criteria under section 304 or 303 of the Clean Water Act, State Water Quality Criteria Standards or State ARARs, RCRA regulations or other appropriate and relevant guidelines, regulations, or standards may be considered.

3.3 Approach to Alternative Evaluation

The following factors will be used as the basis for evaluating remedial alternatives. The factor will provide a consistent basis for comparison of remedial alternatives. Specific evaluation factors are listed and summarized below:

1. Technical Feasibility

The technical feasibility will be evaluated based on the following factors:

- Proven technology - Has the technology been successfully applied in a similar remedial action project?
- Reliability - Is the technology dependable; can equipment be expected to operate with a minimum of downtime?
- Operability - Is the technology simple to operate; can it be practically operated under the site field conditions?
- Flexibility - Will the technology operate efficiently under variable conditions (i.e., safety constraints required by nature of the contaminated soils or varying hydraulic loadings for a groundwater treatment system)?
- Equipment availability - Is the equipment commercially and readily available for field application or can a long delivery time be expected?
- Susceptibility to toxic contaminants - Is the technology subject to upset due to the presence of toxic constituents (i.e., soil and groundwater treatment processes)?
- Implementability - Alternatives considered must be implementable in a relatively short time to minimize costs.

2. Institutional Factors

The institutional factors that will be considered in the evaluation of remedial action alternatives include:

- Acceptability by Federal and State regulatory agencies.
- Safety (i.e., on-site and off-site requirements during implementation of the alternatives).
- Public acceptance.
- Permits and licenses (i.e., air or water discharge permits; construction or operations permits).
- Long-term land use.
- Long-term management agency requirements.
- Permanent reduction through mobility, toxicity, or volume (M,T or V) as required by Section 121 of SARA.
- Short-term and long-term uncertainties associated with land use; the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

3. Environmental and Public Health Factors

The purpose of remedial action at the site is to respond to, and if feasible, rectify any existing and potential future environmental effects and mitigate conditions that could potentially affect public health, welfare, or the environment in the area. Therefore, the ability of a remedial alternative to mitigate or eliminate these impacts is important. Remedial alternatives will be evaluated considering their ability to:

- Prevent human access or possible contact with the contaminated materials after site work is completed.
- Abate/minimize existing and potential future groundwater migration and contamination.
- Minimize any potential additional impacts during remedial action operations on air, land, surface water, and groundwater.

- Minimize any potential adverse impacts on human health, wildlife and vegetation, neighboring properties, and other sensitive populations.
- Abate/minimize existing and potential future migration and contamination of air, soils, and surface waters.
- Address the short-term and long-term risks associated with implementing the specific alternative.

4. Cost Effectiveness

A remedial clean-up program must not only be technically feasible for meeting the environmental objectives of the remedial action, but must also be amenable to being implemented in a cost-effective manner. In evaluating the cost-effectiveness of various remedial alternatives, costs for each alternative will be identified by taking into consideration capital and investment costs, labor/expenses, operating costs, and any long-term maintenance costs. If appropriate, a present worth method, approved by EPA, will be utilized for cost comparison purposes. The cost of alternatives will be compared to the alternative which meets all pertinent regulations.

3.4 Identification of Data Requirements

The review of available data has provided the following information concerning the American Chemical Services, Inc. site which includes the Griffith Landfill and Kapica Drum, Inc. (now Pazmey Corp.) property.

1. General information concerning geology and hydrogeology of the area from published studies and reports. Some site specific soils information is available from on-site soils borings and off site well logs.
2. Specific information as to the types and quantities of wastes disposed of by ACS.
3. Non-specific information as to the types and quantities of waste disposed of by Kapica Drum, Inc. Basically all that is known is that Kapica Drum, Inc. reconditioned drums containing hazardous and non-hazardous residues from ACS and other clients. It has been reported the drum residue and rinse water was disposed of on Kapica Drum property and ACS property. In addition, this information is second-hand since it was supplied by ACS, not Kapica Drum, Inc.

4. Specific information as to the types of waste disposed of by ACS at the Griffith Landfill.
5. Non-specific information concerning the types of waste disposed of by Kapica Drum, Inc. at the Griffith Landfill. Again, this is second-hand information supplied by ACS.
6. Specific information concerning the location of known waste disposal on ACS property and areas of suspected soil contamination.
7. Non-specific information concerning the location of waste disposal on Griffith Landfill property.
8. Specific but limited data concerning on-site migration of hazardous wastes on ACS property. No data is available concerning hazardous waste migration from suspected disposal locations on Kapica Drum, Inc. or Griffith Landfill property.
9. Very limited data concerning waste migration outside of ACS, Kapica Drum, Inc. and Griffith Landfill property. In particular, there is very little data concerning groundwater contamination.
10. Detailed information concerning property ownership was available; however, there is a question as to whether or not part of the ACS Off-Site Containment Area is on Griffith Landfill property.

The information needed to fill the available gaps in the data are as follows:

1. The following information is needed concerning on-site geology:
 - a. Stratigraphy at the site determined by boreholes extending to bedrock.
 - b. Characterization of geotechnical, hydrological, and geological parameters of the soils and sediments on site.
 - c. Confirmation of the given geological data including well logs and hydrogeologic data such as hydraulic conductivities and transmissivities.
 - d. Better definition of the water table configuration.

- e. Better definition of the permeability, extent and continuity of the clay layer.
2. Specific information concerning the types of quantities of hazardous wastes disposed of by Kapica Drum, Inc. and accepted for disposal by the Griffith Landfill. In general, more information concerning the disposal of hazardous materials by Kapica Drum, Inc. and Griffith Landfill is needed. A request for information similar to that sent to ACS by the U.S. EPA would provide useful information.
3. A more detailed characterization of the waste as it exists now on the ACS property.
4. A more detailed evaluation of the extent of migration of contaminants from the site. This includes the ACS, Kapica Drum, Inc. and the inactive portion of Griffith Landfill property.
5. More detailed information concerning potential impact to receptors. Specifically, a survey of public water supplies should be conducted to determine those residents that use groundwater, including determining which aquifer is used. Selected wells will be sampled and analyzed for hazardous waste constituents.
6. More detailed information on the current ACS operations including process piping, water usage, effluent volumes, effluent quality and spill containment, and control plans.

3.5 Remedial Investigation/Feasibility Study Objectives

The objectives of the RI/FS include:

- Determining the nature and extent of any release or threatened release of hazardous substances, pollutants or contaminants from the American Chemical Services, Inc. facility.
- Identify relationship between current contamination and origin/source.
- Define the potential for future off-site contaminant clean-up.
- Identify/develop standards and criteria for contaminant cleanup.

- Evaluate present and future risk and potential for harm to public health, welfare, or the environment.
- Assess remedial action alternatives for the appropriate extent of remedial action to prevent the migration or release or threatened release of hazardous substances from the American Chemical Services, Inc. facility.
 - Identify technological options for cleaning up and preventing migration of contaminants beyond the site boundaries.
 - Evaluate remediation alternatives consistent with the National Contingency Plan, other regulatory requirements and considering applicable guidelines.
 - Recommend the remedial action that is technically and environmentally sound, and cost effective.
- Supply the basis for preparing the Record-of-Decision.

SECTION 4 REMEDIAL INVESTIGATION SCOPE OF WORK

This section of the Work Plan describes the site investigation activities that will be conducted during execution of the project. Various project plans that address specific issues of project execution, that require more detailed treatment than the scope of a typical work plan would include, are being prepared as supporting documents to the Work Plan. The following three plans, having individual scopes as described below, are being prepared:

- Health and Safety Plan - including a Site Evaluation form (SEF) which covers personal protective equipment needed depending on location and activity within the site, contingency plans and emergency procedures, field monitoring equipment, and decontamination procedures. Also included in the Health and Safety Plan will be a section concerning site management. This section will address operations at the site including site access security, site office decontamination facilities, equipment and materials needs and storage, communications and support functions, and coordination of sampling activities.
- Quality Assurance Project Plan - covers QA data measurement objectives, sampling objectives and procedures, sample custody, calibration procedures, internal QC checks, QA performance audits, QA reports, preventive maintenance, data assessment procedures, corrective action, and field protocols.
- Sampling and Analysis Plan - covers data collection objectives, sample locations, sample identification numbering, sampling equipment and procedures, sample analysis and handling, sample documentation and tracking, sampling team organization, and sampling schedule. The sampling and Analysis Plan will be an appendix to the Quality Assurance Project Plan. This will be a document to be used in the field, as well as in project planning.

Under the Superfund Amendments and Reauthorization Act of 1986 (SARA), it is recommended that the RI and FS are integrated so that parts of each are conducted concurrently. Therefore, the project will be conducted in several phases of investigation. Each phase will be designed to make optimal use of

information as it is derived and to produce the information which is necessary to complete the FS. Because this approach makes use of the most current information, data overlaps and data gaps are minimized. The phased approach allows "mid-course" corrections to be made so that the investigation will develop in the most efficient and cost-effective sequence. This Work Plan presents the conceptual details for the first two phases. Additional phases would be developed if and when it were to be determined that additional information would be required which had not been developed in Phases I and II. Reports and technical memoranda for each phase will include discussions of the significance of each phase to the whole RI/FS process. An outline of the Phase I and Phase II activities consists of:

PHASE I - REMEDIAL INVESTIGATION

I. TASK 1 - PROBLEM DEFINITION

- A. Review Available Information
 - 1. Published data (USGS, ASCS, etc.)
 - 2. Site visit and interviews
 - 3. Aerial photographs
 - 4. Water use survey
 - a. Domestic wells including commercial and residential wells
 - b. Industrial and municipal wells
 - 5. Review available reports (RCRA submittal, etc)
- B. Survey Site Boundaries
 - 1. Establish site grid
 - 2. Survey site boundaries
- C. Geophysical Survey
 - 1. Magnetometer/gradiometer (where effective)
 - a. On-site containment area (E on Figure 2-1)
 - b. Off-site containment area (C on Figure 2-1)
 - c. Old still bottoms (F on Figure 2-1)
 - d. Treatment pond (G on Figure 2-1)
 - e. Kapica drum draining area (L on Figure 2-1)
- D. Surface Water Survey
 - 1. Set up surface water bench marks

- E. Environmental Audit of ACS
 - 1. Coordinate with RCRA audit
 - 2. Evaluate process streams
 - 3. Define potential sources

F. Establish Remedial Alternatives

II. TASK 2 - HYDROGEOLOGIC INVESTIGATION

- A. Characterize Flow System
 - 1. Monitor ACS hydraulics
 - a. Evaluate volumes
 - 2. Evaluate landfill hydraulics
 - a. Install leachate wells
 - b. Monitor de-watering pumpage
 - 3. Install perimeter monitoring wells
 - a. Test near surface hydraulic properties
 - 4. Install piezometer grid
 - 5. Model groundwater flow system
 - a. Conduct water balance
 - b. Determine groundwater flow paths and rates
- B. Initial Shallow Sampling
 - 1. Effluent sampling
 - 2. Groundwater sampling from perimeter wells
 - 3. Surface water and sediment sampling

III. TASK 3 - NEAR SURFACE CONTAMINATION INVESTIGATION

- A. Waste Characterization
 - 1. Soil borings at ACS (E F G M on Figure 2-1)
 - 2. Leachate Sampling
 - a. Leachate Wells in Landfill
 - 3. Waste volume calculation

PHASE II REMEDIAL INVESTIGATION

IV. TASK 4 - PHASE II SITE CHARACTERIZATION

- A. Groundwater Characterization
 - 1. Install eight new shallow monitoring wells
 - 2. Install four lower aquifer monitoring wells
 - a. Extend stratigraphic description
 - b. Conduct hydraulic property tests
 - 3. Sample existing and new monitoring wells

- B. Soil Contamination
 - 1. Additional Soil Sampling
- C. Groundwater Transport Model

PHASE III - REMEDIAL INVESTIGATION

V. ADDITIONAL CONTAMINATION INVESTIGATION

- A. Install Additional Monitoring Wells as Necessary
 - 1. Upper aquifer
 - 2. Lower aquifer
- B. Collect Additional Samples as Necessary

VI. ENDANGERMENT ASSESSMENT

4.1 RI TASK 1 - PROBLEM DEFINITION

Task 1 will consist of gathering available information regarding the site and using non-invasive investigative techniques at the site to better define potential problems that should be investigated in subsequent phases.

4.1.1 Review Available Information

The Project Team will obtain, review, and evaluate existing information which can help define the origin, history, nature, and extent of the environmental problems deriving from the ACS site. Included in the review will be the relevant publications by state and federal agencies (i.e., IDNR, IDEM, EPA, USGS, ASCS, etc.). Climatological data, logs for private and public wells, and other data significant to the groundwater system will be obtained from the appropriate sources. Additionally, any available reports from previous investigations will be obtained for review and possible integration into this investigation.

Aerial photographs will be obtained for available dates back to 1955. These will be used to develop a site history, delineating excavated areas, filled areas, and areas used for drum storage. Several days will be spent on-site

correlating aerial-photo-observations to on-site anomalies. Additionally, personnel who worked for American Chemical Services, Inc. (ACS), the Griffith Landfill, Kapica Inc., and other near-site concerns will be interviewed about their recollections of operational practices and disposal areas. U.S. EPA will be given notice of any interview.

A survey of residential, municipal and industrial wells within a one-mile radius of the ACS site will be conducted. If results indicate contamination from the ACS site appears to be extending beyond that one mile radius, the survey may be extended. The objectives of the survey include:

- Identify water sources in the area (lake, river, groundwater, etc.).
- Identify the number, type and location of wells in the vicinity of the ACS site. Information concerning well construction (depth, casing and screen materials, screened interval, etc.) will be gathered.
- Determine if the private wells pump from the upper or lower aquifer below the ACS site.
- Determine which private wells should be sampled as part of the remedial investigation work.

4.1.2 Survey Site Boundaries

A site boundary survey will be conducted in order to accurately define the study boundaries and delineate the ACS, Griffith Landfill, and Kapica Drum, Inc. (now Pazmey Corporation) property boundaries. Existing survey data will be used to the fullest extent possible in order to minimize the need for additional surveying. The survey data will be utilized to prepare site maps, locate sampling points and monitoring well locations, and assist in determining which parties must be contacted to obtain property access permission for off-site investigation activities. The survey work will also be used to determine if the Griffith Landfill property boundary overlaps the ACS off-site drum containment area. In addition, the boundary survey will identify those other parties who own property that has had hazardous materials stored and/or disposed on it.

All boundary surveys will be conducted by a licensed Indiana surveyor. Permanent boundary markers will be installed as necessary in order to easily distinguish individual pieces of property. These boundary marker locations shall be marked with a sign so they are easy to locate in any heavy vegetation.

A grid system will be established in the field at the ACS site to allow accurate siting of sampling points, and allow mapping of historic waste disposal site and contaminated areas. The grid will be based upon two perpendicular baselines with a maximum grid interval of 100 feet. Site (ground) elevation data will be collected at selected grid points to establish elevations of sampling locations. The elevation data could also eventually be used to establish initial ground control elevations during initial site remediation activities and to estimate soil quantities for cut/fill calculations. The grid system will also provide ground control for geophysical surveys. The grid system will be shown on sample location maps in the final RI Report.

4.1.3 Geophysical Surveys

If feasible, a geophysical survey will be conducted in order to more accurately define the extent of drum disposal areas (i.e., potentially contaminated areas). Because of the presence of railroads, power lines, metal buildings, and metal process tanks across and surrounding the site, geophysical methods may be of limited utility. Survey by magnetometer has the best probability of yielding meaningful data. After a test to determine feasibility, the method would be used to locate drums in the ACS Off-Site Containment Area, On-Site Containment Area, Old Still Bottoms Pond and Treatment Pond #1 and the Kapica Drum, Inc. drum draining area. The data collected will be utilized to finalize soil boring and monitoring well locations.

4.1.4 Surface Water Survey

A series of surface water bench marks will be established across the site so that surface water elevations can be determined at the same time groundwater monitoring wells are sampled. The bench marks will be referenced to U.S.G.S. elevations. The resulting data will be used to document the interaction between surface and groundwater and should allow determination of whether the marshes which surround the site are discharge areas or recharge sources.

4.1.5 Environmental Audit of ACS

An environmental audit will be conducted of the ACS facility to determine if it currently contributes to the groundwater system. The audit will include an examination of process streams and an assessment of the integrity of product piping, sewer piping, drains, and the effluent transport system. Site access and the cooperation of ACS management will be necessary for successful completion of this task. Also, this will be coordinated with the U.S. EPA and the State of Indiana RCRA personnel. Starting information includes the pending RCRA permit, the ATEC January 15, 1986 report, the Subsurface Soil Exploration of Griffith Sanitary Landfill November 7, 1986, and other available reports.

It is anticipated that the results of the audit will suggest that some type of monitoring of the ACS facility would be prudent. This monitoring could consist of flowmeters on influent and effluent, timed samples of the effluent wastestreams, or sampling devices that are connected to portable detection equipment such as pH meters or Organic Vapor Analyzers.

4.1.6 Establish Remedial Alternatives

Results from the Feasibility Study, (Section 5), will be used to evaluate and rank the possible remedial actions according to economic, environmental, technical, and institutional considerations. To conduct a thorough Feasibility Study, a data base should be developed which characterizes the

media, the contaminants, and the potential migration pathways, according to the specific remedial actions which are feasible for the site. To develop a complete data base, possible remedial activities will be listed and screened for potential feasibility based on the results of a review of available information and limited non-intrusive site investigations. From this list, a short list will be developed, containing only the remedial procedures which are viable for the hazardous compounds, contaminated media, and potential pathways which are at the site. This short list will provide focus for refining the data quality objectives (DQO).

The original complete list and the short list of Remedial Alternatives will be provided along with a brief justification for each selection. The list will be considered flexible, open to amendment and deletion as the RI progresses.

4.1.7 Technical Memorandum

A technical memorandum will be prepared to document the activities undertaken with RI Task 1. This memorandum will also provide detailed results of each survey including: 1) Property boundaries map; 2) a grid and surface elevation map; 3) results of the local groundwater utilization survey; 4) results of the geophysical surveys; 5) results of the environmental audit of ACS; and 6) a list of Potential Remedial Alternatives.

4.2 RI TASK 2 HYDROGEOLOGIC INVESTIGATION

4.2.1 Characterization Flow System

After the problem areas have been delineated in Task 1, the setting of the problem, the shallow groundwater flow system, will be characterized in Task 2. The focus of this subtask will be to determine the groundwater flow directions in the shallow aquifer. Specifically, the subtask will:

- Evaluate the details of on-site soil stratigraphy and the stratigraphy in adjacent off-site areas.

- Determine the hydrogeologic conditions in the upper aquifer, including vertical and horizontal groundwater flow conditions on site and in adjacent off-site areas.
- Determine the configuration of the water table in the upper aquifer on site and in adjacent areas off site.
- Identify surficial drainage features and flow patterns, and characterize the relationship of surface water to groundwater on site and in adjacent off-site areas.
- Characterize the extent of surface water and sediment contamination on site and in adjacent off-site areas.

Regional groundwater flow in the vicinity of the ACS site is reportedly to the northeast; however, due to several features near the site, flow patterns on site are not well defined. Turkey Creek, is located one mile to the south. The only other major surface water body is the Little Calumet River, three miles to the north, therefore, there may be a local drainage divide through or to the north of the site. Griffith Landfill has also excavated 30 feet of soil material and is pumping to control the inflowing water, which will also affect local groundwater flow.

Based on existing subsurface data, the hydrostratigraphy at the site appears to consist of:

- An upper aquifer fine-to coarse-grained sand with fine to coarse gravel, and small amounts of peat and silt, about 20-feet thick.
- An intervening silty clay to clay unit containing discontinuous lenses of gravel, 15 to 30-feet thick.
- A lower sand and gravel aquifer, 90-feet thick.

A fourth soil unit consisting of thick, stiff clay is reported in the area, but borings indicate it is absent on site. The deeper sand and gravel unit is the major water supply aquifer in the area. The depth to bedrock, which consists of interbedded shales and dolomites, is about 130 feet.

To determine if the on-going ACS operation has a current impact on the groundwater flow system, a water budget will be conducted to account for the total water usage within the facility. The total water extracted from on-site wells or obtained from off-site sources will be compared to the volume of water discharged to sewers. Additionally, a system will be established to monitor the quality of effluent discharged from plant operations. Completion of this task will require cooperation from ACS.

Installation of groundwater monitoring wells will provide the data needed to determine the vertical and horizontal directions of groundwater flow and the horizontal and vertical extent of contamination. Also, they will provide better stratigraphic and geotechnical information concerning sediments under the site.

During Task 2, six monitoring wells will be installed around the perimeter of the ACS site (Figure 4-2). The wells would be constructed with 10-foot screens located to intersect the water table. If the aquifer is thicker than 15 feet, and the results of sampling indicate the necessity, Phase II monitoring wells could be constructed to sample the lower part of the upper aquifer. The purpose of the wells would be to define potential contaminants migrating away from the site. In addition, areas found to be uncontaminated would be potential areas for locating wells that would penetrate into the lower aquifer in Task 4.

A detailed water table map will be necessary to define the flow directions and gradients across the site. A series of temporary piezometers and wells will be installed within the site in an approximately rectangular grid to augment the surface water level data and provide the groundwater elevation data necessary to develop a water table map for the upper aquifer. The groundwater grid will include the six perimeter monitoring wells and several leachate wells in the landfill. Slug tests, bail tests, or pump tests will be

conducted in three of the six Phase I monitoring wells to determine the hydraulic properties of the aquifer. Specific wells to test will be selected to represent upper aquifer conditions. Criteria for selection will include saturated thickness and grain size. Placement of wells in the landfill will require cooperation from the Griffith Landfill. The locations of the piezometer grid and leachate wells are shown in Figure 4-1. In areas outside of the landfill, the piezometers would be installed by jetting them into the ground. Within the landfill, they would probably be installed with a drill rig. Screens for the piezometers will be set at the top of the first saturated layer. Under no circumstances would piezometers be installed through the base of the landfill. Piezometers will be installed with caps which can be "pop-riveted" in place to seal the well and avoid tampering.

It is anticipated that water levels in the piezometers would be measured at least twice during the course of the RI. Levels at the piezometers and surface water points will be measured within a week after they are installed, and again before the Phase I field work is complete. Uncertainty in field conditions, scheduling, and site access does not allow more specific scheduling. If possible, measurements would also be made during both dry and wet periods, and collected at several closely-spaced intervals immediately after a major precipitation event to determine the response of the system to major surface water inflow.

The information developed in Tasks 1 and 2 will be synthesized using a groundwater flow model. The purpose of the model would be to conduct a water balance of the site and determine the groundwater flow paths and rates in the near surface aquifer. Since two aquifers will be analyzed, it is anticipated that the U.S.G.S. Three-Dimensional Groundwater Flow Model (Modflow) will be used. The model is capable of simulating groundwater flow within and between aquifers. It can simulate stresses to the aquifer(s) by actions such as: flow from external sources, flow to wells, areal recharge, evapotranspiration, flow to drains, and flow through riverbeds. Additionally, the head values derived in modeling can be used to develop hydraulic gradients, velocity field, and estimate solute transport rates.

4.2.2 Initial Shallow Sampling

During Phase I of the remedial investigation, surface water and sediment samples will be collected, some residential wells may be sampled, and some groundwater monitoring wells will be installed and sampled. Based on the results of Phase I, Phase II monitoring wells will be installed and sampled, and samples will be collected at water supply wells downgradient of the site. One upgradient water supply well will also be sampled.

It is anticipated that based on results of the environmental audit of the ACS facility, four sampling locations will be defined. Samples will be collected from these four areas as part of Task 2.

The most significant migration pathway by which contamination at the ACS site may migrate is via groundwater, particularly the upper aquifer. In 1982, four shallow (approximately 20 ft.) test wells were installed by the FIT. A groundwater sample collected from one of these wells (Test Well 1-Figure 2-1) was found to contain organic chemicals, including benzene, toluene, and trichloroethylene. Monitoring wells, soil boring samples, water level measurements, permeability tests, and geotechnical testing of soil samples will be used to characterize this potential migration pathway. Private water supply wells will be sampled as a precaution for protection of the public health and to provide information regarding the presence and extent of contamination in the lower aquifer, which is the main aquifer used for water supply in the area. Private wells adjacent to the site, set in the upper aquifer (Unit 1, defined in Section 2.1.1) would be sampled in Phase I. Private wells screened in the lower aquifer (Unit 3 defined in Section 2.1.1) downgradient of the site will be sampled in the second phase after groundwater gradient has been determined in that aquifer. At least one sample will be collected upgradient of the site to indicate background water quality.

The Phase I monitoring wells will be instrumented with 10 foot screens located to intersect the water table. If results of Phase I sampling indicate the need for collecting samples of groundwater deeper in the aquifer, deeper wells will be designated in subsequent phases of investigation.

In addition to the sampling of groundwater monitoring wells, samples will be collected from four leachate piezometers installed at the Town of Griffith Landfill. The purpose of the leachate samples is to characterize the leachate quality within the landfill. Samples will be collected from wells that represent conditions that may have been encountered during various stages of the landfill development.

Surface water drainage from the site may contain hazardous contaminants. In addition, contaminated groundwater could be discharging to nearby surface water bodies - marsh west of the ACS property and the excavated area at the toe of the working face in the Griffith Landfill. Water that collects in this low area is periodically pumped into a municipal sanitary sewer. Contaminants could also be accumulating on or migrating with sediments that are eroded off the site. Eleven samples of surface water and sediment will be collected and analyzed to assess these possibilities. The approximate locations of these eleven pairs of surface water and sediment samples are shown in Figure 4-3. Sampling locations will include Treatment Pond 2 (Location 1), the ACS Retention Pond (Location 2), a drainage ditch at the southwest corner of the ACS plant (Location 3), the marsh (Location 4), ponded water near the Off-Site Drum Containment Area (Location 5), the Griffith Landfill excavation (Location 6), three sites along a drainage ditch (including a small pond north of the railroad track) connecting the marsh to Turkey Creek (location 7), and a drainage ditch that is parallel to Colfax Avenue south of the intersection of Colfax Avenue and Reder road (Location 8) in addition drainage ditch 1800 feet southeast of the ACS site; is designated as Location 9, although it falls beyond the limits of Figure 4-3.

The Phase I sampling effort is summarized in Table 4-1, and the sampling analysis program is presented in detail in Table 4-2.

A technical memorandum will be prepared upon completion of Task 2 to document actual activities and present the findings. The technical memorandum specific to site characterization will address, as a minimum, the following subjects:

1. Hydrogeologic conditions in the study area; identification and characterization of soil stratigraphy and areal relationships of soil deposits; identification and characterization of hydrostratigraphic units and areal relationship; evaluation of groundwater flow systems, flow directions, flow rates and recharge-discharge distribution.

2. Sampling and analysis of water supply wells and groundwater; identification of contaminant levels in all the hydrostratigraphic units investigated both on and off site during the phases which have been completed; evaluation of potential contaminant migration across the site boundary and into the water supply aquifer.
3. Sampling and analysis of surface water and sediment; identification of on-site contaminant levels; elevation of off-site contaminant migration.

4.3 RI TASK 3 - NEAR SURFACE CONTAMINATION INVESTIGATION

There are insufficient data regarding the volume, concentration, and character of waste disposed at the American Chemical Service (ACS) site. ACS has provided some information on the approximate location and general nature of waste disposal on-site, but additional data are needed. Therefore, an investigation of the known disposal sites (the Still Bottoms Pond, Treatment Pond 1, the On-Site Drum Containment Area, the Off Site Drum Containment Area, and the Kapica Dump Site) will be completed during Phase I of the remedial investigation. This will involve sampling of the waste and the natural soil materials underlying the waste. There is also evidence that waste material has been spilled or dumped on the ground in the Drum Storage Area and possibly within the old Kapica Drum (now Pazmeyer Corporation) property. Investigation of these areas will involve sampling of surficial and subsurface soils for characterization of residual contamination.

The sampling program to be implemented as part of the RI/FS at the American Chemical Services site in Griffith, Indiana, will evaluate and characterize the location, nature and volume of the contaminated areas on site including the old Still Bottoms Ponds, Treatment Pond 1, Kapica Dump Site, the On-Site Drum Containment Area and the Off Site Drum Containment Area.

The scope of sampling activities to be conducted as part of the source characterization task includes surface soil sampling, drilling of 14 soil and waste borings and excavation of six waste pits. Chemical analysis to detect

priority pollutants and other hazardous materials will be performed on 48 investigative samples. Depending upon the results of source sampling, it may be necessary to conduct RCRA tests on some samples. For example, RCRA waste characteristic tests such as ignitability or E.P. toxicity may be specified for some waste samples. The sources characterization sampling effort is summarized in Table 4-3, and the sampling analysis program is presented in detail in Table 4-4. A qualified geologist or geotechnical engineer will log all excavation and drilling activities. Additional test pits and soil borings may be conducted in Phase II of the investigation.

Three source areas are known to contain buried drums - the On-Site Drum Containment Area, the Still Bottoms Pond and Treatment Pond 1 (see Figure 4-4). In two of these areas (Still Bottoms Pond and Treatment Pond 1), the drums were dumped, crushed and compacted and it is expected that fill materials will consist of a mixture of waste residue and drum carcasses. Test-pits will be used to allow collection of waste samples and soil samples from at least one foot into natural soil. The approximate locations of the test pits are shown in Figure 4-4 (Locations E, F, G). If a liner is encountered, excavation will cease. The liner shall not be penetrated. One pit will be sufficient in the On-Site Drum Containment Area (Location E), two pits are needed in the Still bottoms Pond (Location F) (parts of which now have process structures built on top), and three will be needed in the Treatment Pond No. 1 area (Location G). In each test pit, one composite waste sample, consisting of 5 discrete samples, and one natural subsoil sample will be collected. This sampling in conjunction with geophysical studies will provide data for evaluating the volume, concentration, and character of the wastes in these source areas. Data will also provide the basis for assessing the extent to which the wastes are moving into adjacent soil materials.

Test borings will be used to collect waste and natural soil samples in two of the source areas - the Off-Site Drum Containment Area, and the Kapica Dump Site (see Figure 4-4). Although there is evidence of a substantial number of drums buried in the Off-Site Drum Containment Area, borings are proposed (rather than test pits) because there is a clay cap over the area and it seems likely that the drums are not densely packed. It is anticipated that the drums disposed of in this area were crushed and the fill materials will consist of a mixture of waste residues and drum carcasses. Thus there should be less damage to the integrity of the cap with a good probability of successfully defining the extent of contamination. The approximate locations of the test borings are shown in Figure 4-4 (Locations C and L). Five borings will be drilled in the Off-Site Drum Containment Area (Location C) with one composite waste sample, consisting of 5 discrete samples, and one natural soil sample will be collected in each boring. Three borings are planned for Kapica Drum Site (Location L), which apparently consists of alternating layers of drum sludges and soil. One composite waste sample and one natural subsoil sample will be collected from these borings. This sampling will provide data for evaluating the volume, concentration and character of the wastes in these source areas and for assessing the extent to which the wastes are moving into adjacent soils materials. If the magnetometer survey or attempted boring indicate that test borings will not be possible, it may be necessary to excavate test pits as described above.

In both the ACS Old Drum Storage Area and the former Kapica Drum property (see Figure 4-5), there is evidence indicating that minor drips, spills and leaks of various chemical substances did or could have occurred. Resulting residual contamination of the unsaturated zone, if there is any remaining at this time, would be dispersed throughout relatively large areas. Composite soil samples will be used to provide a general characterization of any residual contamination in these potential source areas. The approximate Phase I locations of the sampling areas for the soil area samples are shown in Figure

4-5 (Locations E, P, R, O). The on-site containment area will be divided into four sampling areas (Location E) and the former Kapica Drum property will be divided into two sampling areas (Location O). Within each sampling area, soil will be collected at five discrete sites at one depth interval - 6 to 18 inches. Each soil sample will be qualitatively screened for organic vapors using HNu or OVA. Samples will be composited by depth within each sampling area. In addition to these composite samples, grab samples will be collected at two specific areas - near the former fume incinerator (Location P) and at the site of a previous spill/fire (Location R) - at the same depth interval. The exact location of the fume incinerator of the spill/fire site will be specified by American Chemical Service. These soil samples represent Phase I numbers and locations. Additional phases of investigation may be necessary.

Specific data regarding the vertical distribution of residual soil contamination in the Old Drum Storage Area (see Figure 4-5) is needed to complement the general data regarding areal extent obtained from the soil area samples. This data will be collected using six vertically sampled soil borings. The approximate locations of the soil boring samples are shown in Figure 4-5 (Location M). The borings will be located on the basis of qualitative organic vapor screening performed during soil area sampling so that attenuation profiles can be developed for a range of near-surface contaminant conditions. In each soil boring, samples from depths of 2-2.5 feet and 4-4.5 feet will be submitted to the laboratory for chemical analysis. Second phase sampling may be used to refine definitions of the depth and extent.

A technical memorandum will be prepared upon completion of the source characterization field work to document the field activities and present the findings. The technical memorandum specific source characterization will address, as a minimum, the following subjects:

- Sampling and analysis of waste from pits and borings; identification of source areas and type and extent of contamination.

- Sampling and analysis of soil on site from composite and grab samples and soil borings; identification of on-site contaminant levels in soil including areal extent and depth, evaluation of contaminant mobility and attenuation.

4.4 RI TASK 4 - PHASE II SITE CHARACTERIZATION

4.4.1 Groundwater Characterization

Based on the results of the work conducted during Task 2 and 3, it is anticipated that at least 8 and up to 12 new monitoring wells will be installed in Task 4. Although the need for, the location, and the number of second phase wells is currently unknown, 4 Phase II wells will penetrate to the top of the lower aquifer and at least 4 and up to 8 of the wells would be additional shallow wells. The purpose of the shallow wells would be to further define the extent of contamination in the upper aquifer. The purpose of the lower wells would be to extend the stratigraphic description of the site, determine vertical gradients between the two aquifers, and investigate potential contamination of the lower aquifer. All monitoring wells constructed during the RI/FS (6 in Phase I and up to 12 in Phase II) will be sampled following installation and development. After all wells have been sampled for the full Target Compound List, it may be anticipated that the Phase I and II wells will be re-sampled; up to half will be analyzed for the full Target Compound List, and the remaining wells (with EPA review and comment) may be sampled only for compounds indicated in prior sampling.

A survey as described in Task 1 will be performed to identify sources of drinking water and groundwater utilization within one mile of the site. Existing data suggests that the main areas of groundwater use for drinking water are to the south and east of the site. All known private, industrial, and commercial production wells within 1 mile of the ACS site are plotted on Figure 1-4. The plot also indicates the depth of the screened interval. Four

Phase II monitoring wells will be constructed in the upper part of the sand and gravel aquifer (Unit 3). Water levels will be measured in these during Phase II so that the hydraulic gradient in the aquifer can be determined. On the basis of the groundwater flow direction, the production wells within one mile downgradient of the site will be sampled. A private well, just across Colfax Avenue on Reder Road will be sampled. If it is one of the downgradient wells, one upgradient well will be sampled to provide an indication of background groundwater quality. It is anticipated that 10 wells will be sampled. Information covering well construction (depth, screened interval, materials, etc.) will be obtained, if possible, for each residential well that is sampled.

4.4.2 Additional Soil Sampling

Based on the results of the work conducted in Task 3, it is anticipated that additional drilling, sampling, and analysis will be required to define the lateral and vertical extent of soil contamination at the site. The actual need and location of the samples would be determined in Task 3. It is anticipated that up to 20 soil samples would be collected for analysis. It is anticipated that after U.S.EPA review and comment samples will only be tested for the compounds detected at each location during Phase I sampling.

4.4.3 Groundwater Transport Model

The role of the groundwater model is to formulate the appropriate questions and to help in obtaining quantitative answers of sufficient accuracy and detail to guide in decision making. The role of models is not to provide precise answers to the questions which have been posed. Rather, the model should be used to produce information needed to guide the thinking underlying the decision to be made. If modeling is conducted, the proposed model and associated assumptions will be submitted to the U.S. EPA for review and approval.

Mathematical models have the potential for performing the following functions:

1. Organization - One of the biggest problems encountered in planning or design is to represent and display in simple terms the numerous characteristics of complex systems and proposed plans. Models serve an invaluable function in providing a basis for such representation and for actually carrying out much of the computation which is required for this organization.
2. Amplification - When properly used, models can amplify available knowledge of the behavior of complex systems. Models do not produce new information; however, they permit the extraction of greater amounts of information from the existing database. In this sense, they increase understanding of the problem under study and of the options for dealing with it.
3. Evaluation - Models can be designed to incorporate measures of performance of the system under study and may therefore be designed to produce comparative evaluations of performance. Modeling can project or predict the consequences of alternative future actions, including the no-action alternative.

The hydraulic conductivity of the penetrated aquifer will be estimated by conducting slug test on selected completed wells. The basic concept behind these tests is that the rate of rise of the water level in a well after an "instantaneous" displacement of a "slug" of water is a function of aquifer hydraulic conductivity. Thus by measuring water levels at various times following displacement of the slug, the hydraulic conductivity can be calculated. To be a meaningful test, it is necessary to quickly displace a fairly large volume of water and readily and accurately measure water levels in the well. Analysis of test data should use appropriate computational methods such as that presented by Bouwer, H. and R.C. Rice, 1977, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells," Water Resources Research, Vol. 12, No. 3, pp. 423-428 of Nguyen and Pinder, 1984. If indicated, a pump test might be conducted.

A total of 8 wells will be used for aquifer testing by the slug test method. All of the lower aquifer wells constructed in Phase II (4 wells in Unit 3) will be tested, and 4 of the monitoring wells completed in the shallow aquifer (Unit 1) will be tested. The four shallow wells will be selected to be most representative of the shallow aquifer, and to be best suited for conducting tests by the slug method (i.e. the geologic material must be characteristic of average upper aquifer materials, and the well should cut across at least 75% of the aquifer).

Hydraulic conductivity testing of monitoring wells installed at the ACS site will be performed as follows:

- An initial measurement of static water level will be made.
- A volume of water will then be displaced as rapidly as possible using a calibrated solid cylinder or compressed air. Highly permeable conditions ($K \geq 10^{-3}$ cm/sec) are anticipated.
- Water level changes in the well will be sensed and recorded by a pressure transducer connected to an electronic data logger. Water level measurements will be collected automatically on logarithmically increasing time steps, starting at 0.003 minutes (i.e., the first 10 measurements will be taken at the following elapsed time: 0, 0.003, 0.007, 0.010, 0.013, 0.017, 0.020, 0.0233, 0.026, 0.030). The total test time could last from several minutes to several hours for each well.
- The data will be plotted in the field (water level vs. log time) using semi-log paper to determine if the data are sufficient to establish a reasonable straight-line relationship.

This Work Plan presents the conceptual details for the first two phases of investigation. Additional phases could be developed if and when it were to be determined that additional information would be required which has not been developed in Phases I and II. After completion of the first and subsequent phases, meetings will be held among the PRP representatives, the PRP's consultant, the IDEM, DOI, and U.S.EPA to develop the scope of the next phase.

4.5 RI TASK 5 - FEASIBILITY STUDY TESTING

During the development and initial screening of alternatives, laboratory and bench scale studies and modeling may be needed to determine the overall implementability, operability, reliability and cost effectiveness of a particular alternative.

Laboratory studies, pilot scale studies or supplemental studies that may be needed to determine engineering design and operating criteria for full-scale operation of the chosen technologies are discussed below. If laboratory studies are deemed necessary based on work activities, a separate work plan, schedule and budget will be developed for IDEM and U.S. EPA approval. This work will be submitted in a time frame that maintains steady progress of the overall feasibility study.

4.5.1 Treatability Studies

Treatability investigations that may be required include:

- Waste fixation technologies to ensure that any encapsulation alternatives will effectively provide containment of the wastes located on the site.
- Treatability with a physical/chemical or biological process to determine loading effectiveness, required sizing, chemical and other material requirements for treatment of groundwater and/or storm water run-off from the site.
- Incineration pilot studies to determine contaminant destruction efficiencies, design criteria, materials handling requirements and sidestream (i.e., off gases and ash) treatment/handling/disposal requirements.

4.5.2 Compatibility Studies

One remedial action alternative that may be considered is the use of contaminant migration barrier walls. The compatibility of soil bentonite wall and waste material deposited on the ACS site and leachate being generated on the site may have to be investigated. In addition, any synergistic reactions that could occur when different waste materials and decomposition by-products are mixed will be examined.

4.6 RI TASK 6 - DATA VALIDATION

The data validation task will be conducted by the Project Team.

4.7 RI TASK 7 - CONTAMINANT PATHWAY AND TRANSPORT EVALUATION

This task will involve the identification of contaminant transport pathways. The pathways that will be investigated include soil (unsaturated zone), groundwater, surface water and air. The evaluation developed under this task will be used as the basis for the work to be conducted under Task 8 - Endangerment Assessment.

4.7.1 Unsaturated Soil Zone

Numerous soil samples will be collected during the on-site remedial investigation. The soil sampling survey is described in detail in the Sampling and Analysis Plan. The information that will be collected will be used to evaluate contaminant pathways and transport pathways includes the following:

- The type of contaminants present
- The extent of contamination (i.e., delineation of contaminant zones)
- Contaminant solubilities
- Contaminant densities
- Contaminant amenability to soil absorption/adsorption
- Volatility of contaminants

This type of information will allow a determination to be made concerning the directions (i.e., pathways) contaminants are migrating from various disposal locations on the ACS site. Data will also determine whether the contaminants are being transported through the unsaturated soil zone into the groundwater or being attenuated in the soil.

4.7.2. Groundwater

Groundwater sampling will also be conducted during the on-site remedial investigation work. Information gained through potential groundwater sampling will allow delineation of the type and extent of groundwater contamination both on and off site. Specific contaminant characteristics, such as solubility and density in conjunction with hydrogeologic data, such as soil hydrologic conductivity and transmissivity, will allow determination of such items as:

- Projected direction and rate of contaminant transport in the groundwater;
- Estimated volume of contaminated water (and contaminants) present;
- Determination of whether contaminants would collect at the interface of the aquifer surface and the unsaturated soil zone or settle through the aquifer and become concentrated along the surface of the underlying bedrock (or even seep into the fractured bedrock);
- Whether contaminants would be dissolved (solubilize) in rainwater as it percolated through the soil and be leached out and subsequently transported into the underlying aquifer.

4.7.3 Surface Water

Surface water sampling will also be conducted during the remedial investigation task. This will allow determination of off-site migration of contaminants. Migration could be occurring via one of the following pathways:

- Recharge of surface streams with contaminated groundwater;
- Contaminated stormwater run-off from the ACS site;
- Discharge of contaminants from the marsh area which borders the west side of the ACS site.

Prior to 1974, according to ACS, some process wastewaters were discharged into the marsh area west of the ACS site. The stream that runs through the marsh could be absorbing contaminants as it passes through the marsh and transporting them off site. In addition to collecting surface water samples, sediment sampling will also be conducted.

4.7.4 Air

Based on the review of existing information, (e.g., the Hazard Ranking System scores) the ambient air is not considered to be a contaminant pathway and no air sampling is proposed. However, during excavation and boring operations planned for the remedial investigation it is possible that contaminated surface soil particles (i.e., fugitive dust), and volatile organic emissions from the waste material disposal and spill areas will be released in the vicinity of the drilling or excavation area. Therefore, limited air monitoring for personnel protection will be conducted.

4.8 RI Task 8 - Endangerment Assessment

An endangerment assessment will be conducted to establish the extent to which contaminants present at the site or released from the site may present a danger to the public health, welfare, or the environment. This endangerment assessment will evaluate conditions at the site in the absence of any further remedial actions, i.e., it will constitute an assessment of the "No-Action" remedial alternative. This endangerment assessment will be conducted consistent with applicable EPA draft guideline documents. The following eight factors will be considered:

- Contaminants found at the site
- Factors affecting migration
- Environmental factors
- Exposure evaluation
- Toxicity evaluation
- Environmental impacts
- Data gaps and recommendations
- Quality assurance

4.8.1 Contaminants Found at the Site

Information on the identity, quantity, physical state, and concentrations on contaminants found at the site will be summarized in tabular and/or graphic form and will be used as the basis for the transport and exposure models outlined below. Specifically, data on source strengths and ambient concentrations in soil, groundwater, and surface water will be summarized. (Air is not considered a significant exposure pathway at this site.) Special attention will be paid to the reliability of analytical data and the tabulations will ordinarily be limited to those data validated by acceptable QA/QC procedures.

A short list of contaminants of primary concern for hazard evaluation will be compiled. This list will include, at a minimum, the following compounds preliminarily identified in the soil, surface water and groundwater at the site: phenol, chlorinated ethanes, chlorinated ethenes, phthalates, heavy metals and cyanide. Any other contaminants found at or near the site during the RI will be screened for inclusion in the list. In particular, if polychlorinated biphenols (PCBs), pesticides, maleic anhydride, methanol or formaldehyde (compounds that are known to have been disposed of at the site) are found at or near the site during the RI, these will be given special attention in screening. The screening of contaminants will be based on quantities present, potential for exposure, and toxicity (using toxicity indices such as reference doses, ambient water quality criteria or unit risks). This information will be used to derive a hazard index to permit comparison and ranking the relative hazards posed by each chemical found during the RI. Based on this ranking, a short list of contaminants of primary concern will be compiled, and a preliminary report will be prepared for review by EPA and EPA's technical consultants. After approval of the short list by EPA, the remainder of the endangerment assessment will be limited to consideration of the chemicals on the short list of indicator chemicals.

4.8.2 Factors Affecting Migration

Information on topography, soil environment, geological environment, hydrological characteristics, and climate will be summarized to serve as the basis of exposure models, as discussed below.

4.8.3 Environmental Fate of Contaminants

Physical and chemical characteristics of contaminants will be derived from standard sources and will be used to characterize the environmental persistence of each chemical, as well as its propensity to migrate in various media and to transfer from one medium to another. Specifically, a detailed evaluation will be made of the persistence and mobility of PAHs, chlorinated solvents, and other compounds in soils under the conditions prevailing at the site, including their tendency to be absorbed to soils and other materials present at the site, and their tendency to leach into groundwater. This evaluation will also take into account, to the extent possible, differences in physical and chemical properties among different organic species and will evaluate the potential for differential persistence or mobility of the more toxic species. The evaluation will take into account the presence of hydrocarbons, phenols, or other solvents that may increase leaching through the clay confining layer below the site. A similar evaluation will be made of the mobility of metals and of any other contaminants included in the short list.

Specific routes of contamination that would be considered are:

1. Leaching of contaminants into the shallow Calumet Aquifer, followed by transport in shallow groundwater to points where groundwater discharges to surface water (potentially the marsh west of the site) or to areas where groundwater may be withdrawn for use.
2. Transport of contaminants into the deep aquifer (the Valparaiso Aquifer), with the specific goal of predicting concentrations of contaminants in areas where the aquifer is used for drinking water supply.

3. Contaminated surface run-off or erosion of contaminated soil particles into surface water drainage.
4. The fate of the contaminants in off-site surface waters (if the results of No. 3 above indicate potential or actual transport of contaminants into these water). The evaluation will take into account dilution, degradation, spatial dispersion, biological uptake, and bioconcentration in food chains.

Other routes of transport that will be considered to the extent necessary to evaluate their potential significance include direct contact with contaminated soils by on-site worker and tracking of contaminated soils off site by vehicles, humans, or animals.

The objective of contaminant transport evaluation will be to derive estimates of ambient concentrations of contaminants both on site and off site and hence to estimate exposure by human and wildlife receptors. Therefore, the evaluation will be focused on areas where potential receptors have been identified and need not attempt to generate a detailed description of the movement of levels of contaminants into remote areas.

4.8.4 Exposure Evaluation

In the first stage in the exposure assessment, the populations at risk will be described. For human populations, this will include the number and distribution of residents and workers (both on site and off site), the demographic characteristics of the population, and projections for changes in future decades (obtainable from government and commercial sources). At the ACS site, an evaluation will focus on human exposure via potential consumption of contaminated groundwater. Any especially sensitive populations (children, older person, etc.) will be identified. If off-site transport of contaminants is found likely to occur, wildlife populations at risk will be defined using information from governmental and private surveys, supplemented by focused field investigation, if needed. Applicable EPA guidelines and current practices will be followed in compiling and presenting this information.

In the second stage in exposure assessment, scenarios for exposure will be constructed. These scenarios will include, at a minimum, the following:

1. Direct contact with contaminated surface soils by present or future users of the site.
2. Current or future consumption or other use of contaminated groundwater, if migration of contaminants into groundwater is found to be a significant exposure pathway.
3. Consumption of contaminated water and sediment by wildlife, either through groundwater recharge of surface waters or direct contact via surface run-off.

4.8.5. Toxicity Evaluation

A detailed summary of the toxicity of each of the contaminants on the short list will be presented. Toxicity summaries should be obtained from the Integrated Risk Information System (IRIS) initially; this information will be supplemented with more recently updated information on toxicity and human health from the EPA's verified reference doses (RfDs) evaluations by EPA's carcinogenic assessment group (CAG) and health effects assessments (HEA) documents. Computerized literature searches may be conducted to identify any more recent studies that may require consideration and/or modification in hazard assessment. Quantitative assessment of toxic hazards at predicted levels of exposure will follow current EPA procedures.

The potential for synergistic effects will also be evaluated. Accordingly, special attention will be paid to circumstances in which sequential exposure to chemicals might occur.

4.8.6. Environmental Impacts

The substantial effects on vegetation or wildlife, if any, caused by chemicals released at the site, will be assessed by comparing the predicted ambient concentrations of contaminants with those known to be toxic to test species.

4.8.7 Data Gaps, Recommendations, and Questions

This section of the Endangerment Assessment will define data gaps and questions, and may include recommendations for further site investigation, if data gaps are of such nature that endangerment assessment cannot be finalized without further site investigations.

4.8.8 Quality Assurance

The Endangerment Assessment will be based exclusively on analytical data that have been subjected to approved QA/QC procedures, unless there is specific reason to make an exception (e.g., if the only data available are unvalidated or partially validated). In addition to QA/QC for the analytical data, the results of transport modeling, exposure assessment, and toxicity assessment will be subject to Quality Assurance. This will include, at a minimum, review of the assessments by a qualified scientist.

4.8.9 Health Assessment

A Health Assessment will be conducted by the Agency for Toxic Substances and Disease Registry (ATSDR). Data obtained through the RI process will be supplied to ATSDR.

4.9 TASK 9 - REMEDIAL INVESTIGATION REPORT

4.9.1 Draft Remedial Investigation Report

A draft remedial investigation report will be prepared to consolidate and summarize the data obtained and documented in previously prepared technical memoranda during the remedial investigation. Data gaps and the need for any additional remedial investigation field work will be determined. The proposed Remedial Investigation Report Table of Contents is shown below:

REMEDIAL INVESTIGATION REPORT

TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 OBJECTIVES

2.0 BACKGROUND

3.0 INVESTIGATION METHODOLOGIES

4.0 INVESTIGATION DATA PRESENTATION

5.0 INVESTIGATION ANALYSIS

REFERENCES

APPENDICES

The RI will provide the site characterization, a summary of data collected and the conclusions of the site investigation analysis. The draft report will be submitted for U.S. EPA and IDEM review. The following is a summary of the draft RI report contents.

- EXECUTIVE SUMMARY

The executive summary will provide condensed overview of the report. The format of the executive summary will follow the sections of the report. The important characteristics and findings will be briefly presented.

- OBJECTIVES

The objectives section will state the overall objective of the RI and delineate the specific objectives of each of the samplings, investigations, and studies performed. The order of the specific objectives will be set by the chronology of the RI.

- BACKGROUND

The background section will provide the information obtained in the initial site characterization. This section will provide an overview of the past and current activities at the site up to the RI phase.

- INVESTIGATION METHODOLOGIES

The investigation methodologies section will provide the basic methods used to obtain the data and information that is used in the investigation analysis. The order of presentation of the methods will follow the order presented in the objectives section. Specific methodologies will in some cases be presented in the appendices. Separate subsections should be provided for each sampling, investigation or study performed.

- INVESTIGATION DATA PRESENTATION

The data will be described as raw data for this section. The findings of each sampling, study or investigation will be presented. The basic data will be presented in appendices where appropriate.

- INVESTIGATION ANALYSIS

The investigation analysis will provide the conclusions drawn from the data presented in the previous section. The first subsection will provide the overall conclusions drawn from all the samplings, studies, and investigations. Specific analyses of the individual sets of data will follow the order previously set.

4.9.2 Agency Review

The draft RI report will be submitted to U.S. EPA in accordance with the Consent Order. Agency comments will subsequently be incorporated into the document.

Upon completion of agency review, a meeting will be held among the Project Team, U.S. EPA project staff and representatives of IDEM. The purposes of the meeting are as follows:

- To discuss the contents of the remedial investigation report.
- To determine the remedial action objectives.
- To identify alternative operable units associated with remedial actions to be addressed in the feasibility study.

A list of operable units and potential remedial actions will be prepared by the project team prior to the meeting to provide a basis for the discussion.

On the basis of the review meeting, a revised draft remedial investigation report will be revised to include U.S. EPA and IDEM review comments as appropriate. This final report will be subject to the approval of IDEM and U.S. EPA. A public meeting may be held or fact sheets may be prepared and distributed by the U.S. EPA or IDEM at this time. Community Relations Activities are discussed separately in Section 4.10, Community Relations Support. The scope of the feasibility study, as presented in this work plan, will be reviewed and modified as appropriate to incorporate the results of the review meeting.

4.9.3 Public Meeting

A public meeting may be conducted, or fact sheets may be prepared and distributed by EPA and IDEM to present the important findings of the remedial investigation and alternative proposal for considerations at the ACS site. The purpose of the meeting or fact sheets would be to inform the concerned citizens regarding plans for mitigating hazards existing at the site and to solicit comments for possible inclusion in the final remedial investigation report. The public meetings are further discussed in Section 4.10.

4.10 Task 10 - Community Relations Support

During the remedial investigation, staff will cooperate with the implementation of the U.S. EPA-approved community relations plan for the ACS site.

The project staff may participate in a "kick-off" meeting announcing the initiation of the remedial investigation.

4.11 RI Task 11 - Quality Assurance

Quality assurance for this project will provide a totally integrated program for assuring the reliability of monitoring and measurement data. A QA Project Plan (QAPP) will specify the procedures which will be implemented to assure that the data gathered at the American Chemical Service site are consistent with specific quality goals of accuracy, precision, completeness and representativeness.

4.11.1 - Systems Audits

A minimum of one system audit will be scheduled in each project phase, as appropriate. EPA may schedule such an audit as appropriate.

4.11.2 - Quality Control

Quality Control (QC) measures will be applied to all tasks and subtasks identified with this Work Plan. The Quality Assurance Program Plan and Quality Assurance Project Plan define Quality Control procedures that will be employed. The Site Manager and Peer Review Group are the principal individuals responsible for QC implementation.

4.12 RI Task 12 - Technical Management

Project Administration encompasses the following subtasks:

- Technical review and oversight
- Meetings
- Technical and financial reporting

Technical review and oversight includes the technical direction and management provided by the Site Manager to the site team from project initiation to completion on topics that are not task-specific.

4.12.1 Technical Reports

Reporting includes the efforts involved in preparing the required monthly technical progress reports for review by U.S. EPA.

Technical Progress Reports will include the following:

- Site identification and activity
- Status of work tasks and progress to date with percent of completion defined
- Difficulties encountered or anticipated during the reporting period
- Actions being taken to resolve problem situations
- Key activities to be performed in the next month
- Changes in personnel

The monthly progress report will list target and actual completion dates for each activity, including project completion. The report will also include an explanation of any major deviation from the work plan schedule.

4.12.2 Document Control

All documents will be filed with proper document numbers according to the Steering Committee consultants Standard Operating Procedures. Alternate monthly meetings of the Project Staff and the U.S. EPA Project Coordinator will be held, if necessary.

SECTION 5
FEASIBILITY STUDY SCOPE OF WORK

5.1 FS TASK 1 - PRELIMINARY REMEDIAL ALTERNATIVE DEVELOPMENT

The feasibility study will consist of identification, development and evaluation of alternative remedial action plans based on engineering feasibility, environmental impacts and costs for the selection of an alternative or combination of alternatives that are cost effective, reliable, implementable and mitigate the hazards present at the site.

The development of alternatives will require definition of remedial response objectives, identification of remedial technologies, and identification and development of remedial alternatives.

Remedial action objectives for the site will be established and reviewed by U.S. EPA. These objectives will be based on the endangerment assessment developed for American Chemical Services, Inc. (ACS). Criteria for meeting these objectives will be developed in close consultation with the U.S. EPA and IDEM so that cleanup objectives at the site are met. They will include compliance with 40 CFR 300.68 of the National Contingency Plan, U.S. EPA interim guidance, applicable or relevant and appropriate federal and/or state laws, consideration of existing levels of contamination, and risk factors for identified sources, pathways and receptors.

5.1.1 Remedial Alternatives Identification

Three types of response will be considered: (1) source control; (2) control of contaminants which have migrated off site; and (3) removal and off-site and/or on-site treatment and disposal of either the source or contaminants that may have migrated off site.

For each type of response required, alternative response actions will be identified. For each alternative response action, implementation technologies will be identified and screened. If more than one type of response is involved, alternatives will then be formulated combining response actions (operable units) to form alternatives that address the complete site. The set of alternatives derived from the process will cover the following categories:

- . Alternatives for treatment or disposal at an off-site or on-site facility, as appropriate;
- . Alternatives that attain applicable or relevant and appropriate public health and environmental requirements, standards, policy, or guidance;
- . As appropriate, alternatives that exceed applicable or relevant and appropriate public health and environmental requirements;
- . As appropriate, alternatives that do not attain applicable or relevant and appropriate public health and environmental requirements but will reduce the likelihood of present or future threat from the hazardous substances and that provide significant protection to public health and welfare and the environment. This must include an alternative that closely approaches the level of protection provided by the applicable or relevant and appropriate requirements; and
- . No action alternative.

Development of alternatives includes establishing criteria and standards for alternatives that do not fully comply with existing regulations and standards.

5.1.2 Identification and Screening of Technologies For Implementation

Remedial technologies capable of meeting the remedial response objectives for the site specific cleanup requirements will be identified, described and listed for assembly into a set of viable alternatives. Applicable technologies will be based on the nature of the contamination at the site,

including the geology and hydrogeology; technical literature; and the experience of the project staff. The technologies identified will be on a media-specific basis (i.e., groundwater, soil etc.) as well as interrelationships between media.

The screening will consider and address all of the following items: 1) the contaminant(s) of concern, 2) the concentrations of the contaminant(s), 3) the extent of the spread of the contaminant(s), 4) the characteristics of the contaminant(s), 5) potential pathways and receptors, and 6) acceptable concentrations of the contaminants.

5.1.3 Definition of Alternatives/Operable Units

As discussed in Section 5.1, if more than one type of response is involved, alternatives will be formulated combining response actions into operable units to form alternatives that address the entire site.

5.1.4 Technical Memorandum

A technical memorandum will be prepared which presents the results of the preliminary remedial alternative development. This memorandum will be submitted for Agency review and approval. Approval of the technical memorandum will be required before proceeding to the next task, which is Remedial Alternative Screening.

5.2 FS TASK 2 REMEDIAL ALTERNATIVE SCREENING

The alternatives developed in Section 5.1 and approved by U.S. EPA and IDEM will be further evaluated in this task. The purpose of screening will be to eliminate alternatives that are clearly not feasible or appropriate and will be based primarily on engineering judgment.

Criteria to be included in the evaluation will include:

- Technical feasibility and reliability.
- Environmental and public health considerations.
- Institutional considerations.
- Cost.

5.2.1 Technical Feasibility Screening

This level of screening is to eliminate those alternatives that are not compatible with site and waste source conditions. Proven technology for remediation should be a consideration.

5.2.1.1 Technical Reliability

Technical reliability will be evaluated based on available literature and project team experience. Proven technology will be given a higher evaluation rating than unproven technologies that may give the same or marginally better results.

5.2.1.2 Implementation Screening

Remedial action plans will be evaluated based on implementability, reliability and operability of each component technology that comprises the alternative plan. An implementable alternative is one that must be able to be successfully applied or accomplished in a reasonable time frame. A reliable alternative is one that must be dependable. An alternative that is operable must be both practical and feasible.

5.2.2 Environmental and Public Health Screening

The purpose of this screening is to eliminate alternatives with significant adverse impacts or that do not adequately protect the environment, public health, or welfare.

5.2.2.1 Environmental Screening

The goals of a remedial action include:

- To mitigate impacts upon air, surface water, surface sediment or groundwater quality and including natural resources and their habitats, including reduction of mobility, toxicity, or volume of contaminants.

- To minimize or eliminate groundwater and surface water contamination.
- To minimize impact upon soil.

If these goals can be met by the remedial alternatives, they will be considered to be protective of the environment. Those remedial alternatives that exceed these goals will be rated higher than those that minimally meet or cannot meet the selected goals.

Analysis of environmental effects resulting from the implementation of a remedial strategy is also an important evaluation factor. The purpose of the remedial action is to rectify existing and potential negative environmental impacts. Alternatives that create additional long-term negative impacts will be avoided. By considering and minimizing environmental effects that may result from each alternative, response objectives will be met and public welfare and the environment will be protected.

Thus, alternatives will be evaluated to determine the extent to which they will control the source of contamination and to determine if the alternatives will result in adverse environmental impact. For instance, the risks of moving wastes off site could be an environmental risk in some circumstances. Those alternatives that do not adequately control the source of contamination and result in significant adverse impacts will be eliminated from further consideration.

5.2.2.2 Public Health Screening

Groundwater is the primary factor of concern for public health at ACS. Therefore, public health advisories and federal and state standards shall be considered, with appropriate adjustment in evaluating alternatives. If additional public health concerns are found, they will also be considered.

5.2.3 Institutional Considerations

The purpose of this screening is to eliminate alternatives that do not adequately conform to institutional standards such as RCRA compliance, worker health and safety and state and local permits and codes. Included in this analysis will be consideration of community relations/operations issues.

5.2.4 Cost Screening

The remedial action program for the ACS site must not only be technically capable of addressing the environmental concerns, but it must also be implemented and operated in a cost-effective manner. For cost effectiveness screening, the cost of all applicable technologies can be compared using cost factors such as:

- . Capital costs.
- . Monitoring costs.
- . Operation and Maintenance costs.

The purpose of the cost analysis will be to provide a basis for comparing the economic features of various remedial action alternatives. These costs will be based on site specific conditions such as, the extent of soil contamination, and will also consider costs specific to on-site or off-site disposal options. For initial screening purposes, the costs will be estimated with an accuracy of ± 100 percent.

Capital costs are encountered during the implementation phase for remedial action, but monitoring and maintenance costs continue during the post-closure phase (design life typically 30 years). Monitoring and maintenance operations can represent a substantial portion of the cost of remedial action strategy, depending on the alternative chosen. This is particularly true for treatment options, such as groundwater treatment. Strategies requiring significant maintenance and monitoring will be avoided; however, some level of monitoring and maintenance will be required to evaluate the effectiveness of the remedial action.

An alternative that has higher costs compared to other alternatives and that does not provide substantially greater health or environmental benefits will be excluded from further consideration.

So that these criteria are met, emphasis will be placed on proven technologies for actions to mitigate contamination on and migrating from the ACS site.

5.2.5 Technical Memorandum

A technical memorandum will be prepared which presents the results of the Remedial Alternative Screening. This memorandum will be submitted for Agency review and comment.

5.3 FS TASK 3 REMEDIAL ALTERNATIVE ANALYSIS

Once U.S. EPA and IDEM have reviewed and commented on the initial screening activities described in the technical memorandum, a more detailed investigation of the preferred remedial action alternatives will be initiated.

The following items will be considered in the evaluation:

- Technical feasibility analysis.
- Public health analysis.
- Environmental assessment.
- Institutional analysis.
- Cost analysis.

5.3.1 Technical Feasibility Analysis

The detailed description of alternative remedial action plans will include the following technical considerations:

- A description of remedial technologies for each alternative will be developed. This will include verbal descriptions as well as conceptual drawings and/or process flow sheets of each aspect of the technology, such as waste treatment, contaminated groundwater treatment, etc.

- Special engineering considerations required to implement the alternatives will be identified. These items could include evaluation on a pilot scale basis to determine the applicability or other additional studies required before proceeding with final remedial design.
- Operation and maintenance requirements of the completed remedial alternative will also be identified. The description will highlight the type and frequency of operation and maintenance requirements.
- Monitoring Requirements
Monitoring activities needed for the selected remedial alternative may be similar to the RCRA post-closure monitoring and maintenance requirements. Monitoring may also be needed, at least in the short-term to determine that groundwater contamination is mitigated.
- Off-site disposal needs and transportation plans will be identified for each alternative. Waste characterization will determine the types of off-site facilities that would be required for disposal. From this information, facilities available to handle these materials can be identified. Recommendations of suitable sites will be requested from IDEM. In addition, transportation plans will be developed for the local area. Generally transportation plans are developed only for the local area and will identify transportation routes to major interstate highways for transportation of waste to be managed off site.
- Temporary storage requirements will be identified. This may include storage of waste materials or wastewater before transport from the site. Any temporary storage facility will be designed to minimize the potential for environmental impacts. This may require the erection of a temporary building, pads for run-on diversion, runoff collection or other actions. Any temporary storage requirements will be identified for each alternative. Also included will be a description of the length of time a waste may remain in storage and the maximum quantity of material that would be in storage at any one time.
- Safety requirements unique to implementation of specific plans will be identified. Both on and off site health and safety will be considered. Safety concerns will be addressed for both during and after the cleanup action.

- Potential for Phasing. A description of how the alternative could be phased into individual operable units will be prepared. The description will include a discussion of how various operable units of the total remedy could be implemented individually or grouped to result in a significant improvement to public health, the environment or cost savings.

5.3.2 Public Health Analysis

The Endangerment Assessment described in Task 8 of the RI will constitute the Environmental and Health Assessment of the "No-Action" alternative. For each of the other alternative remedial actions considered in the FS, a parallel assessment will be conducted to evaluate the extent to which each alternative reduces or eliminates the endangerment to public health, welfare, or the environment. For each alternative, the extent to which the remedial action will reduce the source strength and/or the propensity of the contaminant to migrate will be estimated. The results will be used to estimate the extent to which exposure (and hence risk) via each exposure pathway will be reduced. The results will be presented in a tabular or matrix fashion to facilitate comparisons among alternatives. Any alternatives that fail to meet applicable environmental standards or that fail to reduce risks to an acceptable level will be identified.

5.3.3 Environmental Assessment

A focused assessment of the environmental impacts will be performed for each of the remedial alternatives which are evaluated in detail. The assessment will address the environmental impacts of these alternatives and will identify measures to be taken during the design and implementation to mitigate any adverse effects that may occur from implementation of the alternative. This environmental assessment will also identify any physical or legal constraints that will impair or affect the ability to implement each of the alternatives. Compliance with CERCLA, RCRA and, in particular, the National Contingency Plan, will also be evaluated in this environmental assessment.

This assessment also identifies impacts to public health, welfare or the environment if the "no action" alternative is chosen. This is the result of the risk assessment undertaken in the RI. The assessment will provide a basis for comparison of improved benefits to public health, welfare and environment that would result from implementation of other remedial action alternatives.

5.3.4 Institutional Analysis

Technical feasibility and cost-effectiveness do not necessarily insure implementation. Therefore, institutional factors must be considered in the evaluation and selection of the remedial action strategy. Some of the factors that should be considered include:

- Public acceptance.
- Needed permits or licenses.
- Zoning or other land use ordinances.
- Identification of long-term management agencies or entities.

Permits and licenses will be required by state or local units of government. These can include wastewater discharge permits; processing, landfill, or transportation licenses; and construction or operation permits. Zoning or other land use ordinances can also impact this assessment and implementation of remedial action alternatives. Existing zoning, as well as modification of ordinances, may impact the proposed strategies.

Long-term management agencies or entities must be identified during the feasibility study. This agency (state or local) or entity will be required to implement the long-term monitoring and maintenance program. This will include funding, staffing, coordinating, and keeping records on monitoring the site groundwater; maintenance and security; and long-term care costs. As such, the long-term management agency or entity should be identified during the feasibility study process and should have input in selection of the final alternative.

In addition to these criteria, an important factor in the selection of the preferred remedial action alternative is the assessment of potential risks associated with its implementation. Risk assessment for each potential action will be considered in this evaluation.

By adding an institutional factor analysis and risk assessment analysis, additional information on the implementability, reliability as well as the public acceptance of the chosen remedial alternative can be obtained. The resulting output after the completion of this task will be identification of a recommended alternative(s) for implementation.

5.3.5 Cost Analysis

A cost analysis will be developed for each of the remaining alternatives. This analysis will be more definitive than cost effectiveness analysis in the screening of alternatives, and will fall in the range of minus 30 percent to plus 50 percent accuracy. Each cost item will be identified and costed in current dollars. An agreed-upon interest rate will be used in determining the present worth cost of those portions of the projects that may extend over time, such as pumping and treatment of groundwater and long-term monitoring of the site up to 30 (thirty) years. In addition to the present worth cost, annual operation and maintenance costs will be developed for each alternative.

5.3.6 Technical Memorandum

A technical memorandum will be prepared which presents the results of the Remedial Alternative Analysis. This memorandum will be submitted for Agency review and comment.

5.4 FS TASK 4 - COMPARATIVE EVALUATION OF ACCEPTABLE ALTERNATIVES

5.4.1 Technical Considerations

Once the detailed development of the alternatives has been completed, a final comparison of these remedial action alternatives and their component technologies will be conducted. The evaluation criteria will include:

- Reliability.
- Implementability.
- Environmental Effects.
- Ability to meet ARARs.

5.4.2 Incremental Benefits - Cost Analysis

Value engineering will be utilized to compare the alternatives. The cost effective recommendation will result from a detailed evaluation of the alternatives. Each of the alternatives will be ranked. Except for cost, all other criteria are subjective in nature. To evaluate these subjective factors, a weighting system will be developed and will be used to objectively compare all alternatives. A summation of the values for each alternative provides a general ranking of its potential application.

5.4.3 Institutional Considerations

Institutional factors such as public acceptance, needed permits or licenses, zoning or land use ordinances, and identification of long-term management agencies or entities will be considered factors and included in the detailed development and evaluation of alternatives.

5.4.4 Environmental Impacts of Implementation

Upon completion of detailed analysis of remedial alternatives, environmental impacts will also be considered in the final comparison. Compliance with CERCLA, RCRA, the NCP, and State ARARs will be considered in the possible implementation of any alternatives.

5.4.5 Impact Mitigation

The percent of impact that an alternative will have on existing or potential problems will also be a factor considered in the final comparison of alternatives.

5.4.6 Technical Memorandum

A technical memorandum will be prepared which present the results of the Remedial Alternatives Analysis. This memorandum will be submitted for Agency review and comment.

5.5 FS TASK 5 - FEASIBILITY STUDY REPORT

5.5.1 Draft Feasibility Study Report

A proposed table of contents for the Draft Feasibility Study Report is shown in Table 5-1. The draft report presenting the results of evaluation conducted in tasks described in Sections 5.1 through 5.4 will be prepared. On the basis of the entire evaluation process, one alternative or a combination of alternatives will be recommended for consideration. The draft report will be submitted to U.S. EPA, DOI, and IDEM for review.

5.5.2 Revised Feasibility Study Report

Following receipt of review comments as appropriate, a Revised Draft Feasibility Study Report will be prepared incorporating the Agency's comments on the plan. The report will be submitted to IDEM, DOI, and U.S. EPA for final review.

5.5.3 Public Hearing

A three week comment period will be held on the Revised Draft Feasibility Study Report. A public meeting will be held during this period to receive comments and questions on the recommended remedial alternatives. A responsiveness summary will be prepared by the U.S.EPA following this public comment period.

5.5.4 Final Feasibility Study Report

The Final Feasibility Study Report will be prepared following the completion of the EPA decision documentation process. Revisions arising out of this process will be incorporated into the Final Feasibility Study Report. The final report will be subject to approval by U.S. EPA and IDEM.

5.6 TASK 6 - PREDESIGN REPORT

5.6.1 Process Development

Based on the results of the final feasibility study, a predesign report will be prepared for the selected alternative. Initially, the hazardous waste management scheme will be better defined. During this initial process development phase, the individual processes that collectively formulate the total waste handling strategy will be selected. This will be based on the contaminants that must be managed, the degree of removal/destruction that must be achieved, and/or the containment/stabilization alternative selected as a result of the feasibility study.

5.6.2 Conceptual Design

As a basis for preparation of construction documents, a conceptual design memorandum will be prepared. This memorandum does not discuss "why," but is much more specific about "how" engineering will be implemented. The table of contents for the conceptual design memorandum is presented in Table 5-2.

The major purpose of conceptual design memorandum is to lay out the selected alternative from the RI/FS into specific operations, equipment (sized generally), and facilities needed to meet the engineering requirements of the project.

The level of detail during conceptual design will be limited, but it considers the impact of the size limitations on the implementation of remedial actions and construction facilities. It also examines the adequacy of the data base for process development. The conceptual design memorandum will be submitted to the Agency for information purposes.

The conceptual design memorandum discussed in the preceding paragraph provides the basic definition of the proposed project and is used for review of concepts. It does not contain pertinent decisions which will be required before detailed plans and facility designs can be undertaken. The predesign report is prepared utilizing conceptual design memoranda to develop engineering details required for development of the construction documents. The predesign report will address:

- Specific methodology and protocols for movement, staging, sampling, and disposal of waste material
- Logistics of material movement and waste processing capacities on and off site
- For each processing operation on site, the number and size of processing units, pumps, storage capacity, standby units, planned hours of operation, specific utility requirement, etc.,
- Cleanup analytical guidelines which will determine progress and establish when a particular remedial operation is to be terminated.
- Health and safety requirements (specific operations, clothing, and equipment for each on-site task)
- Required temporary facility on site, such as a laboratory, decontamination station for equipment, and change stations for personnel
- Mobile equipment required on site (trucks, payloaders, backhoes, bulldozers, etc.,).
- Estimated schedule for design, procurement, construction, operation, and eventual closure of the site.
- Work outside the scope of design that must be resolved prior to the preparation of construction documents.
- Specify the procedures, extent and limits of the proposed remedial activities.

- Provide a forum upon which to obtain agency input and direction.

Also contained in the predesign report is a preliminary remediation schedule, preliminary specifications outline and conceptual cost estimate. These three items are briefly described in the following section.

The table of contents for the predesign report is shown in Table 5-3.

5.6.3 Preliminary Remediation Schedule

A preliminary remediation schedule will be prepared for final design, bidding, and implementation, including post-closure needs.

5.6.4 Preliminary Specifications Outline

The predesign report will include preliminary specifications which define the physical and chemical characteristics of wastes and contaminated soils to be used in specification of materials for construction. Specifications will be site-specific for all equipment or operations in the project. However, there may be standard sections which apply to standard materials and methods. The specifications will include plans and protocols to meet regulatory agency specifications or regulations.

For purposes of uniformity, specifications will follow the Construction Specifications institute (CSI) format. This format breaks the specifications into divisions: Division 0 and 1 include bidding, contract requirements, and general requirements. Division 2 through 16 are for technical specifications.

5.6.5 Conceptual Cost Estimate

The predesign report will contain preliminary cost estimates which are based on information in the conceptual design memorandum. The cost estimate should reflect comments received during the review stage. The preliminary cost estimate will have a precision within an order of magnitude for preliminary budgetary purpose (plus 50 percent, minus 30 percent).

5.7 FS TASK 9 - COMMUNITY RELATIONS SUPPORT

During the feasibility study, project staff will cooperate with implementation of U.S. EPA's community relations plan for the ACS site. The project staff will prepare a fact sheet summarizing the completed feasibility study.

5.8 FS TASK 10 - QUALITY ASSURANCE

Quality Assurance of the FS will be in accordance with the Standard Operating Procedures for the PRPs consultant. Audits will be performed during the FS to ensure that quality assurance is being maintained.

5.9 FS TASK 11 - TECHNICAL AND FINANCIAL MANAGEMENT

Project Administration encompasses the following subtasks:

- Technical review and oversight.
- Meetings.
- Technical reporting.

Technical review and oversight includes the technical direction and management provided by the Project Manager to the site team, from project initiation to completion on topics that are not task-specific.

5.9.1 Technical Reports

Reporting includes the efforts involved in preparing the required monthly technical progress reports requested by U.S. EPA.

Technical Progress Reports will include the following:

- A description of the action which has been taken during the month relating to the American Chemical Services Site;
- All results of sampling and tests and all other raw data produced during the month relating to the American Chemical Services site and the Appurtenant Areas;
- All plans and procedures completed during the past month, as well as such actions, data, and plans which are scheduled for the next month; and

- Target and actual completion dates for each element of activity, including the project completion, and an explanation of any deviation from the RI/FS project plan or Work Plan schedule.

The monthly progress report will list target and actual completion dates for each activity, including project completion. The report will also include an explanation of any deviation from the milestones in the work plan schedule.

5.9.2 Document Control

All documents will be filed with proper document numbers according to the Standard Operating Procedures of the Steering Committee's consultant.

5.9.3 Meetings

Alternate monthly meetings, general and management in nature, will be held regularly to provide progress updates on work being completed at the site. It is anticipated that the monthly meetings will consist of teleconferences with appropriate members of the Steering Committee, the Steering Committee's consultant, and Agency staff.

SECTION 6
SCHEDULE

The schedule for completion of the RI work defined in this Work Plan is presented in Figure 6-1. It identifies significant milestones as well as elapsed time for each task. Specific timeframes are included in the schedule for periods of review and comment by the U.S.EPA. Any additional review time required by U.S.EPA will result in corresponding increases in the schedule.

A meeting among the U.S.EPA, the IDEM, the technical subcommittee of the PRP group, and the PRP's consultant will be necessary between Phase I and Phase II of the investigation.

The estimated time for completion of the RI is 12 months from the date that authorization is given to proceed with the remedial investigation. It is anticipated that the FS will require another 10 months to complete.

TABLE 2-1
AMERICAN CHEMICAL SERVICES, INC.
DISPOSAL LOCATIONS AND WASTE TYPES

<u>LOCATION</u>	<u>CLASSIFICATION</u>	<u>WASTE TYPES</u>
<u>American Chemical Services, Inc. Property</u>		
Off-site Containment Area (Figure 2-1/Location C)	Documented Waste Disposal Location	Drums of PCB-contaminated waste. 10,000 cubic yards of distillation bottoms (drummed). Drums containing solidified materials. 68 cubic yards of incinerator ash Chlorinated solvents Acetone MEK still bottoms Cresylic acid, cyanide and chromium from plating operation Lead pigments Several hundred cases of empty bottles that had contained 2,4,D and 2,4,5-TP Tank truck containing 500 gallons of solidified paint 200 drums containing solvent solids of benzene, amylacetate, dimethyl aniline, diethylether.
On-site Containment Area (Figure 2-1/Location E)	Documented Waste Disposal Location	400 drums of sludge and semi-solids of unknown type.
Old Still Bottom Pond (Figure 2-1/Location F)	Documented Waste Disposal Location	253,510 gallons and 2,000 drums of still bottom sludge, containing 1,1,1-trichloroethane, trichloroethylene, methylene, chloride, toluene, benzene, and other low boiling point solvents.

TABLE 2-1
AMERICAN CHEMICAL SERVICES, INC.
DISPOSAL LOCATIONS AND WASTE TYPES
(continued)

Treatment Pond Number 1 (Figure 2-1/Location L)	Documented Waste Disposal Location	200 drums containing solvent, solids of benzene, amylacetate, dimethyl aniline, diethylether 41,612 gallons and 1,000 drums containing semi-solid paint, lacquer and ink waste.
Kapica Drum, Inc. Drum Draining Area (Figure 2-1/Location L)	Suspected Soil Contamination Location	Drum residue and drum rinse water from drum recycling operation.
Old Drum Storage Area (Figure 2-1/Location M)	Suspected Soil Contamination Location	Suspected soil contamination from from unknown waste type.
Old Wastewater Trenches (Figure 2-1/Locations I, J, K)	Suspected Soil Contamination	Suspected soil contamination from wastes containing 1,1,1-trichloroethane, trichloroethylene, methylene chloride, toluene, benzene, and other low boiling point solvents.
<u>Kapica Drum, Inc. Property</u> (Figure 2-1/Location O)	Suspected Soil Contamination	Suspected soil contamination from residue and drum rinse water from drum recycling operation.
<u>Griffith Landfill Property</u> (Figure 2-1/Location D)	Suspected Waste Disposal Location	10 gallons per week for 12 years of retained samples containing hazardous substances 2,500 drums of residues from drum recycling operation

TABLE 4-1
SITE CHARACTERIZATION SAMPLING EFFORT

	<u>INVESTIGATIVE</u>	<u>DUPLICATE</u>	<u>BLANK</u>
Groundwater (GW)			
Phase I	6	1	1
Phase II A (up to)	12	2	2
Phase II B (up to) full TCL	9	1	1
*Phase II B (up to) reduced parameter list	(9)	(1)	(1)
Surface Water (SW)	11	2	2
Sediment (SD)	11	2	0
Private Wells (PW)	10	1	1
Leachate (LE)	4	1	1
ACS Effluent (AE)	4	1	1
	<hr/>	<hr/>	<hr/>
SUBTOTAL	67	11	9
Chemical Subtotal	87		
Geotechnical	90		
Geotechnical Subtotal	90		

TOTAL: 177

Note:

* Numbers not included in total

TABLE 4-2
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

<u>SAMPLE MATRIX</u>	<u>FIELD PARAMETERS</u>	<u>LABORATORY PARAMETERS</u>	<u>Phase</u>	<u>INVESTIGATIVE SAMPLES</u>			<u>QA SAMPLES DUPLICATE</u>			<u>BLANK</u>		<u>TOTAL</u>	<u>MATRIX TOTAL</u>
				<u>No.</u>	<u>Freq.</u>	<u>Total</u>	<u>No.</u>	<u>Freq.</u>	<u>Total</u>	<u>No.</u>	<u>Freq.</u>		
Groundwater (Low)	pH	RAS organics package from CLP (except VOA) including 30 tentatively identified parameters	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
		SAS VOA analysis from CLP (low detection limit)	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
	Specific conductance	RAS inorganics package/metals from CLP filtered samples	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
	Temperature	RAS inorganics package/metals and SAS for suspended solids- unfiltered samples	1	2	1	2	1	1	1	1	1	1	4
			2A	5	1	5	1	1	1	1	1	1	7
			2B	*									
		RAS inorganics package/cyanide from CLP filtered samples	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
		SAS for Alkalinity, Chloride, Sulfate, TDS	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
		SAS for Ammonia, Nitrate- Nitrite, COD, TOC	1	6	2	12	1	2	2	1	2	2	16
			2A	12	1	12	2	1	2	2	1	2	16
			2B	*									
Surface Water (Low)	pH	RAS organics package from CLP including 30 tentatively identified parameters	1	11	1	11	2	1	2	2	1	2	15
	Specific conductance	RAS inorganics package/metals from CLP unfiltered samples	1	11	1	11	2	1	2	2	1	2	15
	Temperature	RAS inorganics package/cyanide from CLP unfiltered samples	1	11	1	11	2	1	2	2	1	2	15
		SAS for Alkalinity, Chloride, Sulfate, TDS, TSS	1	11	1	11	2	1	2	2	1	2	15

TABLE 4-2
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM
(continued)

SAMPLE MATRIX	FIELD PARAMETERS	LABORATORY PARAMETERS	Phase	INVESTIGATIVE SAMPLES			QA SAMPLES DUPLICATE			BLANK		TOTAL	MATRIX TOTAL
				No.	Freq.	Total	No.	Freq.	Total	No.	Freq.		
Sediment (Low)	Qualitative organic vapor screening with OVA and HNu	SAS for Ammonia, Nitrate-Nitrite, COD	1	11	1	11	2	1	2	2	1	2	15
		RAS organic package from CLP including 30 tentatively identified parameters	1	11	1	11	2	1	2	--	--	--	13
		RAS inorganics package/metals and cyanide from CLP	1	11	1	11	2	1	2	--	--	--	13
Private Wells (Low)	pH	Acid extractables and base/neutral extractables	2	10	1	10	1	1	1	1	1	1	12
	Specific conductance	Pesticides and PCBs	2	10	1	10	1	1	1	1	1	1	12
	Temperature	Volatile organics	2	10	1	10	1	1	1	1	1	1	12
		Metals - unfiltered samples	2	10	1	10	1	1	1	1	1	1	12
		Mercury - unfiltered samples	2	10	1	10	1	1	1	1	1	1	12
		Cyanide - unfiltered samples	2	10	1	10	1	1	1	1	1	1	12
		Minerals (alkalinity, chloride, sulfate, TDS)	2	10	1	10	1	1	1	1	1	1	12
		Nutrients (ammonia, Nitrate-Nitrite, COD)	2	10	1	10	1	1	1	1	1	1	12
Leachate	pH	RAS organics package from CLP including 30 tentatively identified parameters	1	4	1	4	1	1	1	1	1	1	6
	Specific conductance	RAS inorganics package/metals from CLP unfiltered samples	1	4	1	4	1	1	1	1	1	1	6
	Temperature	RAS inorganics package/cyanide from CLP unfiltered samples	1	4	1	4	1	1	1	1	1	1	6
		SAS for Alkalinity, Chloride, Sulfate, TDS, TSS	1	4	1	4	1	1	1	1	1	1	6
		SAS for Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	4	1	1	1	1	1	1	6

TABLE 4-2
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM
 (continued)

SAMPLE MATRIX	FIELD PARAMETERS	LABORATORY PARAMETERS	Phase	INVESTIGATIVE SAMPLES			QA SAMPLES DUPLICATE			BLANK		TOTAL	MATRIX TOTAL
				No.	Freq.	Total	No.	Freq.	Total	No.	Freq.		
ACS Effluent	pH	RAS organics package from CLP including 30 tentatively identified parameters	1	4	1	4	1	1	1	1	1	1	6
	Specific conductance	RAS inorganics package/metals from CLP unfiltered samples	1	4	1	4	1	1	1	1	1	1	6
	Temperature	RAS inorganics package/cyanide from CLP unfiltered samples	1	4	1	4	1	1	1	1	1	1	6
		SAS for Alkalinity, Chloride, Sulfate, TDS, TSS	1	4	1	4	1	1	1	1	1	1	6
		SAS for Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	4	1	1	1	1	1	1	6
Soil-Wells (Low)	Qualitative organic vapor screening with OVA and HNu	Atterberg Limits (ASTM D 4318-83)	1	18	1	18	0	0	0	0	0	0	18
		Particle Size Analysis (ASTM D 422-63) Sieve analysis and hydrometer analysis	1	18	1	18	0	0	0	0	0	0	18
		Coefficient of permeability (ASTM D 2434-68)	1	18	1	18	0	0	0	0	0	0	18
		Cation exchange capacity (ASTM D 4319-83)	1	18	1	18	0	0	0	0	0	0	18
		Moisture content (ASTM D 2216-80)	1	18	1	18	0	0	0	0	0	0	18

NOTE: Field parameters determined for investigative and duplicate samples only.
 ASTM methods can be found in American Society of Testing and Materials 1984 Annual Book of Standards, Volume 4.08. Soil and Rock; Building Stones.
 Laboratory testing to be performed by a qualified geotechnical laboratory.

* Total Number of Samples and specific parameters will be determined from Phase 1 and 2A sampling results at monitoring wells.
 Preliminary assessment is that up to 9 wells will be sampled for complete TCL, and remaining wells will be sampled for reduced parameter list.

TABLE 4-3
SOURCE CHARACTERIZATION SAMPLING EFFORT

<u>PHASE I</u>	<u>INVESTIGATIVE</u>	<u>DUPLICATE</u>	<u>BLANK</u>
Waste Pit (WP)	6	1	0
Natural Soil Pit (NP)	6	1	0
Waste Boring (WB)	8	1	0
Natural Soil Boring (NB)	8	1	0
Soil Area (SA)	8	1	0
Soil Boring (SB)	12	2	0
	—	—	—
Chemical Subtotal	48	7	0
PHASE I TOTAL:	55		

PHASE II

To Be Defined in Phase I	20	2	0
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PHASE II TOTAL: 22

Notes:

Blanks are not necessary for solid material samples.

TABLE 4-4
SUMMARY OF SOURCE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

<u>Sample Matrix</u>	<u>Field Parameters</u>	<u>Laboratory Parameters</u>	<u>Investigative Samples</u>			<u>QA Samples Duplicate</u>			<u>Blank</u>			<u>Matrix Total</u>
			<u>No.</u>	<u>Freq.</u>	<u>Total</u>	<u>No.</u>	<u>Freq.</u>	<u>Total</u>	<u>No.</u>	<u>Freq.</u>	<u>Total</u>	
Waste Pits (Med)	Qualitative organic vapor screening with OVA and MMu	RAS organics package from CLP including 30 tentatively identified parameters	6	1	6	1	1	1	0	0	0	7
		RAS inorganics package/metals from CLP	6	1	6	1	1	1	0	0	0	7
		RAS inorganics package/cyanide from CLP	6	1	6	1	1	1	0	0	0	7
Natural Soils- Waste Pits (Low)	Qualitative organic vapor screening with OVA and MMu	RAS organics package from CLP including 30 tentatively identified parameters	6	1	6	1	1	1	0	0	0	7
		RAS inorganics package/metals from CLP	6	1	6	1	1	1	0	0	0	7
		RAS inorganics package/cyanide from CLP, SAS	6	1	6	1	1	1	0	0	0	7
		SAS, TOC	6	1	6	1	1	1	0	0	0	7
Waste Borings (Med)	Qualitative organic vapor screening with OVA and MMu	RAS organics package from CLP including 30 tentatively identified parameters	8	1	8	1	1	1	0	0	0	9
		RAS inorganics package/metals from CLP	8	1	8	1	1	1	0	0	0	9
		RAS inorganics package/cyanide from CLP	8	1	8	1	1	1	0	0	0	9
Natural Soils- Waste Borings (Low)	Qualitative organic vapor screening with OVA and MMu	RAS organics package from CLP including 30 tentatively identified parameters	8	1	8	1	1	1	0	0	0	9
		RAS inorganics package/metals from CLP	8	1	8	1	1	1	0	0	0	9
		RAS inorganics package/cyanide from CLP	8	1	8	1	1	1	0	0	0	9
		SAS, TOC	8	1	8	1	1	1	0	0	0	9

TABLE 4-4
SUMMARY OF SOURCE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM
 (continued)

Sample Matrix	Field Parameters	Laboratory Parameters	Investigative Samples			QA Samples Duplicate			Blank			Matrix
			No.	Freq.	Total	No.	Freq.	Total	No.	Freq.	Total	Total
Soil Areas (Low)	Qualitative organic vapor screening with OVA and MWU	RAS organics package from CLP including 30 tentatively identified parameters	8	1	8	1	1	1	0	0	0	9
		RAS inorganics package/metals from CLP	8	1	8	1	1	1	0	0	0	9
		RAS inorganic package/cyanide from CLP	8	1	8	1	1	1	0	0	0	9
		RAS organics package from CLP including 30 tentatively identified parameters	12	1	12	2	1	2	0	0	0	14
Soil Borings (Med)	Qualitative organic vapor screening with OVA and MWU	RAS inorganics package/metals from CLP	12	1	12	2	1	2	0	0	0	14
		RAS organics package from CLP including 30 tentatively identified parameters	12	1	12	2	1	2	0	0	0	14
		RAS inorganics package/cyanide from CLP	12	1	12	2	1	2	0	0	0	14

NOTE: Field parameters determined for investigative and duplicate samples only.
 Blank samples are not required for soil material samples.

TABLE 5-1
FEASIBILITY STUDY REPORT
TABLE OF CONTENTS

EXECUTIVE SUMMARY

1.0 INTRODUCTION

- 1.1 SITE BACKGROUND INFORMATION**
- 1.2 NATURE AND EXTENT OF PROBLEM**
- 1.3 OBJECTIVES OF REMEDIAL ACTION**

2.0 INITIAL SCREENING OF REMEDIAL ACTION TECHNOLOGIES

- 2.1 TECHNICAL CRITERIA**
- 2.2 ENVIRONMENTAL/PUBLIC HEALTH CRITERIA**
- 2.3 INSTITUTIONAL CRITERIA**
- 2.4 OTHER SCREENING CRITERIA**
- 2.5 COST CRITERIA**
- 2.6 DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES**

3.0 REMEDIAL ACTION ALTERNATIVES

- 3.1 ALTERNATIVE 1 (No Action)**
- 3.2 ALTERNATIVE 2**
- 3.3 ALTERNATIVE N**

4.0 DETAILED ANALYSIS OF REMEDIAL ACTION ALTERNATIVES

- 4.1 COST ANALYSIS**
- 4.2 NON-COST CRITERIA ANALYSIS**
 - 4.2.1 Technical Feasibility**
 - 4.2.2 Environmental Evaluation**
 - 4.2.3 Institutional Requirements**
- 4.3 COST-EFFECTIVENESS ANALYSIS**
- 4.4 PUBLIC HEALTH ANALYSIS**

5.0 RECOMMENDED REMEDIAL ACTION

6.0 CONCEPTUAL DESIGN

REFERENCES

APPENDICES

TABLE 5-2
CONCEPTUAL DESIGN MEMORANDUM
TABLE OF CONTENTS

- 1.0 INTRODUCTION**
- 2.0 SITE DESCRIPTION**
 - 2.1 Site Location**
 - 2.2 Site Contamination Problem**
- 3.0 SELECTED REMEDIAL ALTERNATIVE**
 - 3.1 Remedial Alternative Objectives**
 - 3.2 Summary of Screening and Alternative Evaluation**
 - 3.3 Remedial Alternative Technology and Processes**
 - 3.4 Compilation of Relevant Data**
- 4.0 CONCEPTUAL DESIGN OF OPERATIONS, PROCESSES AND FACILITIES**
 - 4.1 Basic Site Preparation**
 - Define the site-specific factors in terms of layout for operations and facilities, rights-of-way, and easements required, access roads, site preparation, etc.
 - Site requirement (analytical services, utilities, etc.)
 - 4.2 Removal of Hazardous Wastes and Contaminated Soils**
 - Staging area for identification and consolidation of materials
 - Bulking or encapsulation of hazardous wastes
 - Ultimate disposal of hazardous materials and contaminated soils
 - Identify transportation route to off-site disposal area, if required
 - 4.3 Treatment of contaminated materials**
 - Define the total facility in terms of the subsections and inter-relationships

TABLE 5-2

**CONCEPTUAL DESIGN MEMORANDUM
TABLE OF CONTENTS
(Continued)**

- Define the space which system operation will require
- Define the size and number of process components
- Define piping and pumping requirements
- Define utility requirements
- Groundwater remedial measures
 - Removal of contaminants from soil
 - Control of contaminated groundwater movement
 - Recovery of contaminated groundwater
 - Treatment of contaminated groundwater
 - Discharge of treated groundwater

4.4 Control of air emissions during hazardous waste removal transport

4.5 Define health and safety procedures and equipment for the specific operations

- Health and safety protocol

5.0 DATA ADEQUACY EVALUATION

5.1 Critically review the RI/FS to determine whether or not site characteristics are adequately defined for design purposes:

- Location and quantities of contained hazardous waste
- Topographic data
- Area and depth of contaminated soil
- Air emissions (type and concentration)
- Groundwater contaminants (type, concentration, and plume definition)

5.2 Review the pilot and bench scale process studies for definition of the selected remedial actions and the availability of fundamental process data.

TABLE 5-2

**CONCEPTUAL DESIGN MEMORANDUM
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(Continued)**

- Is there an adequate estimate of quantities on which a design may be based?
- Are the site limitations suitably defined when considering construction of facilities?

5.3 Define missing information and assist in the development of field investigation and sampling or process development studies which will obtain the necessary information.

6.0 PRELIMINARY COST ESTIMATE

TABLE 5-3

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1.0 INTRODUCTION

2.0 SITE DESCRIPTION

2.1 Site Location

2.2 Site Contamination Problem

3.0 SELECTED REMEDIAL ALTERNATIVE

3.1 Remedial Alternative Objectives

3.2 Summary of Screening and Alternative Evaluation

3.3 Remedial Alternative Technology and Processes

3.4 Compilation of Relevant Data

4.0 REMEDIAL ALTERNATIVE DESIGN

4.1 Operations Design

4.2 Process Design

4.3 Facilities Design

5.0 PRELIMINARY SPECIFICATIONS

6.0 PRELIMINARY COST ESTIMATE

CHICAGO

LAKE

MICHIGAN

HAMMOND

GARY

GRIFFITH

ILLINOIS
INDIANA

INDIANA

north
NO SCALE

FIGURE 1-1



REGIONAL LOCATION MAP
RI/FS

AMERICAN CHEMICAL SERVICES SITE
GRIFFITH, INDIANA

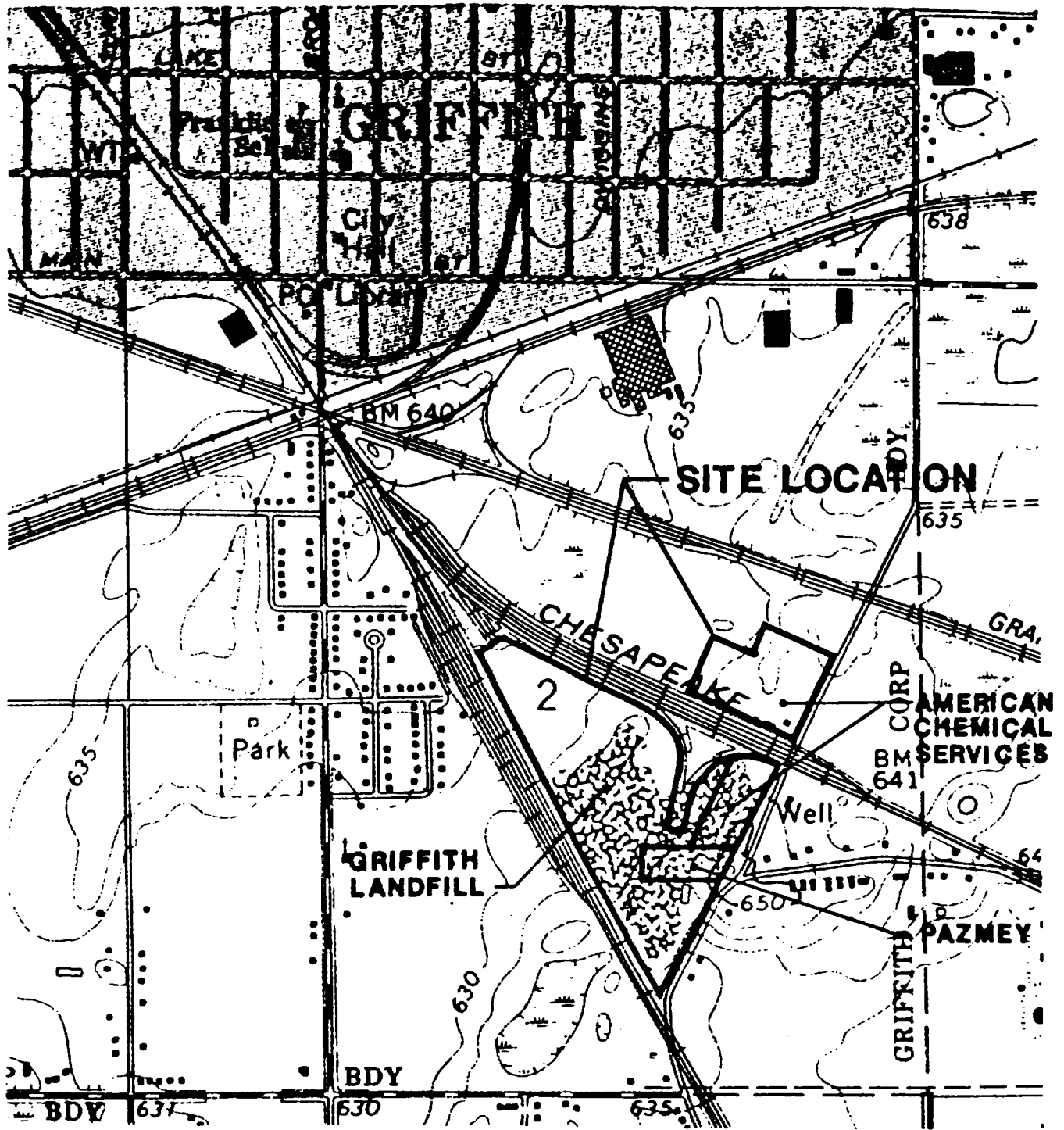
TELETYPE POST NAJ79

OWN SJP

APP'D P5V

DATE 3/28/88

60251-A1



NOTE:

1. SITE LOCATION MAP WAS DEVELOPED FROM U.S.G.S. 7½ MINUTE QUADRANGLE MAP ENTITLED HIGHLAND, INDIANA 1968, PHOTOREVISED 1980.



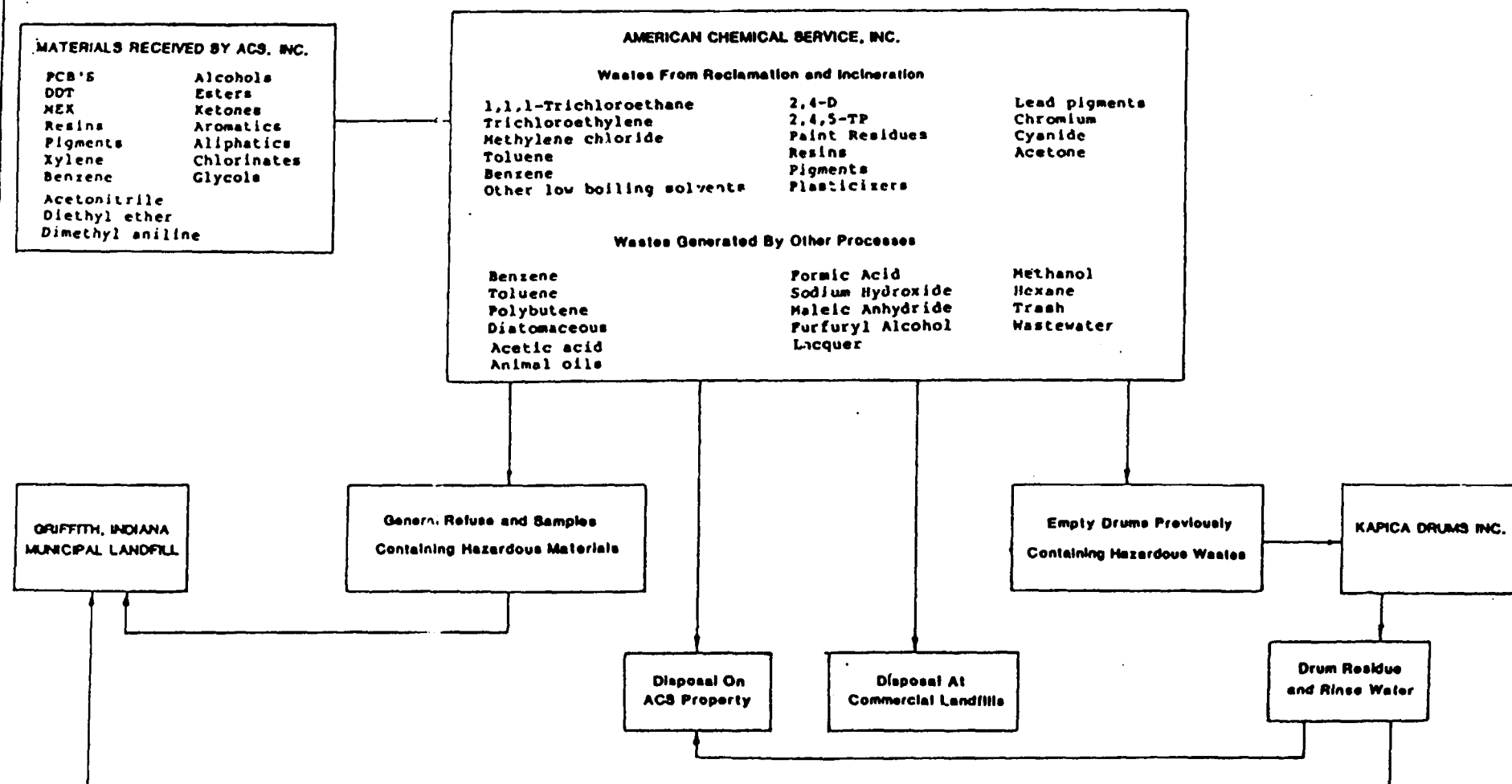
SCALE: 1" = 1000'

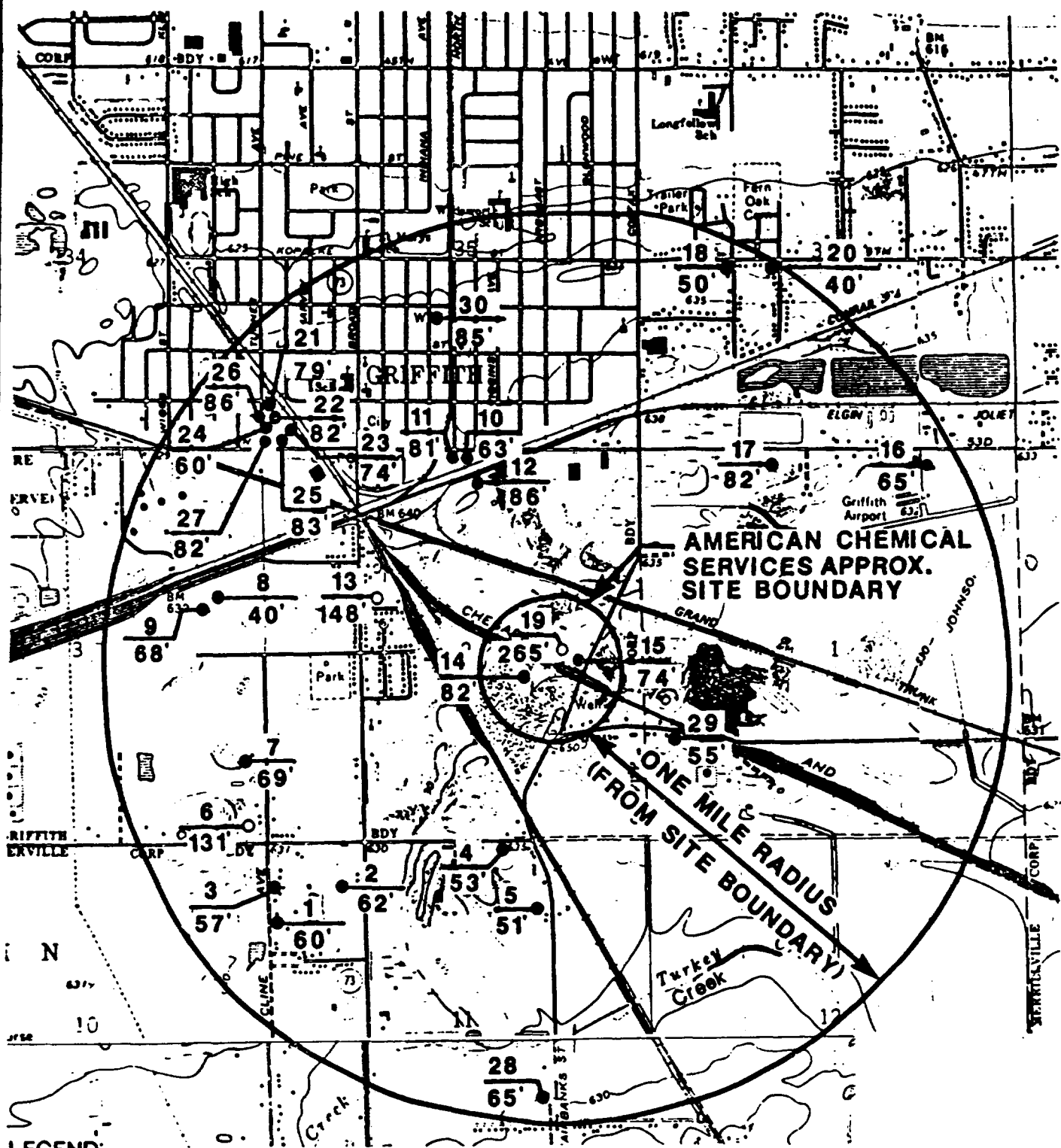
FIGURE 1-2



SITE LOCATION MAP
RI/FS
AMERICAN CHEMICAL SERVICES SITE
GRIFFITH, INDIANA

FIGURE 1-3 WASTE DISPOSAL FLOWCHART





north
SCALE: 1"=2000'

FIGURE 1-4



REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WATER WELL LOCATIONS
AMERICAN CHEMICAL SERVICES SITE
GRIFFITH, INDIANA

OWN JC APP'D PSV DATE 4/25/88 60251-A3

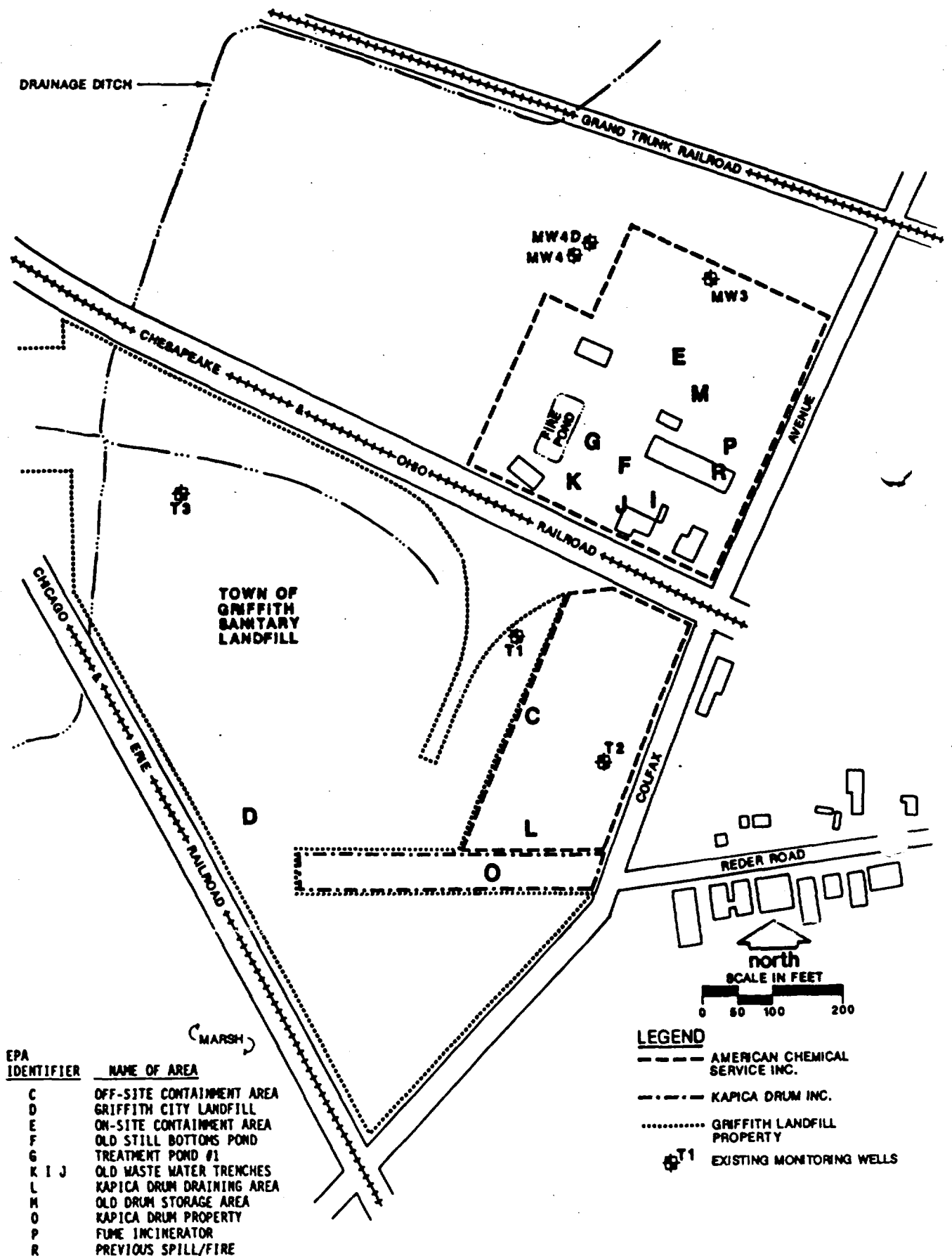


FIGURE 2-1

DRAINAGE DITCH

GRAND TRUNK RAILROAD

CHESAPEAKE

OHIO

MW4D
MW4

MW3

T3

TOWN OF
GRIFFITH
SANITARY
LANDFILL

FIRE POND

K

F

P

R

CHICAGO

D

C

L

O

COLEMAN

REDER ROAD

north

SCALE IN FEET

0 100 200 400

* SEE NOTE

EPA
IDENTIFIER

NAME OF AREA


C OFF-SITE CONTAINMENT AREA
D GRIFFITH CITY LANDFILL
E ON-SITE CONTAINMENT AREA
F OLD STILL BOTTOMS POND
G TREATMENT POND #1
K I J OLD WASTE WATER TRENCHES
L KAPICA DRUM DRAINING AREA
M OLD DRUM STORAGE AREA
O KAPICA DRUM PROPERTY
P FUME INCINERATOR
R PREVIOUS SPILL/FIRE

* NOTE: SURFACE WATER POINT FALLS
BEYOND THE SOUTHEAST BORDER
OF THIS MAP

LEGEND

- AMERICAN CHEMICAL SERVICE INC.
- KAPICA DRUM INC.
- GRIFFITH LANDFILL PROPERTY
- ⊕ T1 EXISTING TEST WELL
- ⊕ PROPOSED SHALLOW PIEZOMETERS
- ⊕ PROPOSED LEACHATE PIEZOMETERS
- △ PROPOSED SURFACE WATER ELEVATION POINTS
- ⊕ MONITORING WELLS PROPOSED PHASE I
- ⊕ PROPOSED LEACHATE SAMPLING WELLS

FIGURE 4-1

 <p>60251-82</p>	HYDROGEOLOGIC STUDY WATER LEVEL CONTROL POINTS		WARZYN <small>ENGINEERING INC.</small> <small>Indianapolis • Chicago • St. Louis</small>		Designed By	Drawn By <i>SL</i>	Checked By
	REMEDIAL INVESTIGATION/ FEASIBILITY STUDY				Approved By		Date
	AMERICAN CHEMICAL SERVICES SITE				Scale	AS SHOWN	Reference
	GRIFFITH, INDIANA				<small>© 1997 - Warzyn Engineering Inc. All Rights Reserved</small>		

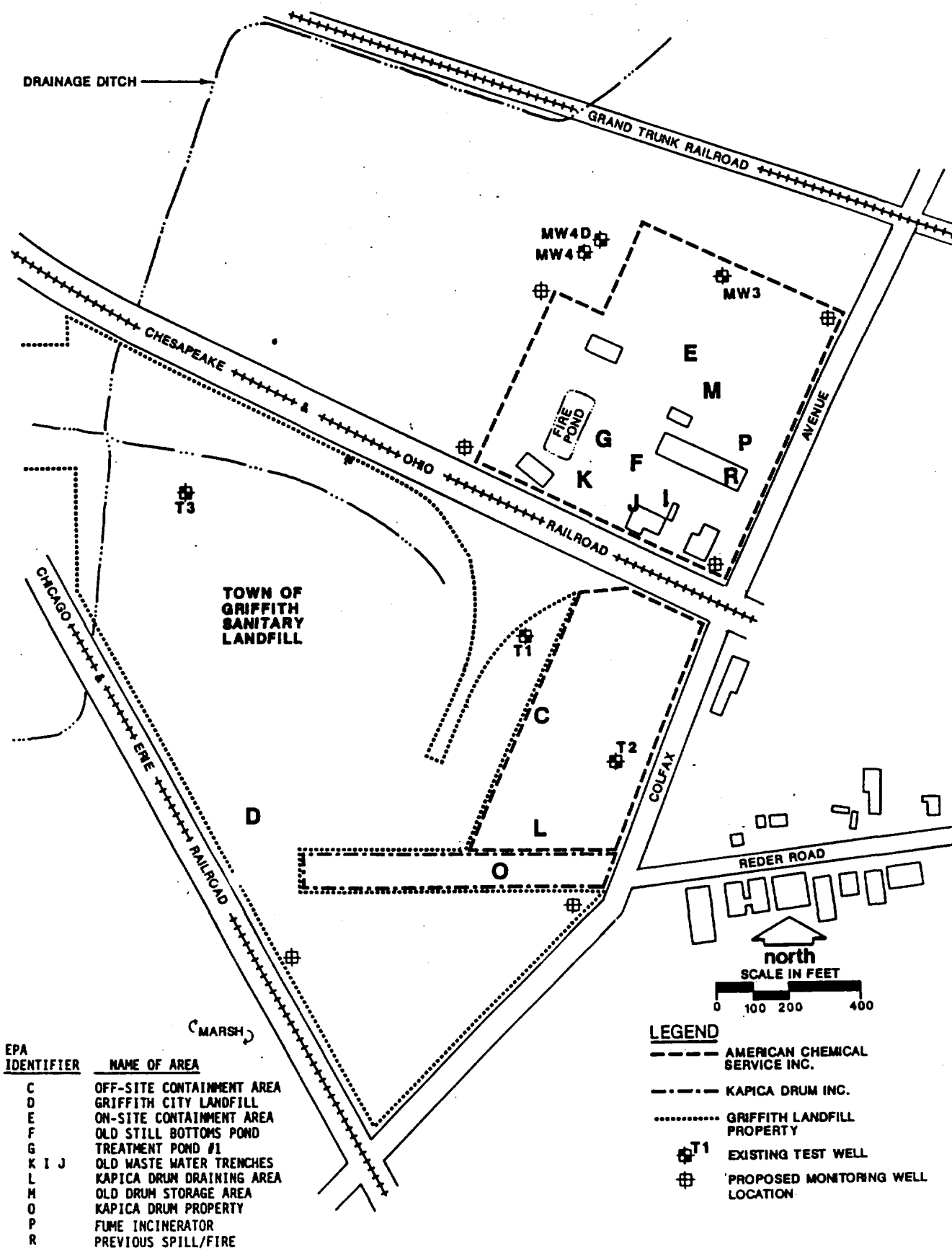


FIGURE 4-2

	PROPOSED PHASE I MONITORING WELL LOCATIONS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AMERICAN CHEMICAL SERVICES SITE GRIFFITH, INDIANA	WARZYN <small>WARZYN ENGINEERING INC.</small> <small>Indianapolis, Indiana</small> <small>Chicago, Illinois</small>	Designed By _____ Drawn By <i>SP</i> Checked By _____ Approved By _____ Date _____ AS SHOWN Reviewed By _____
	60251-83		
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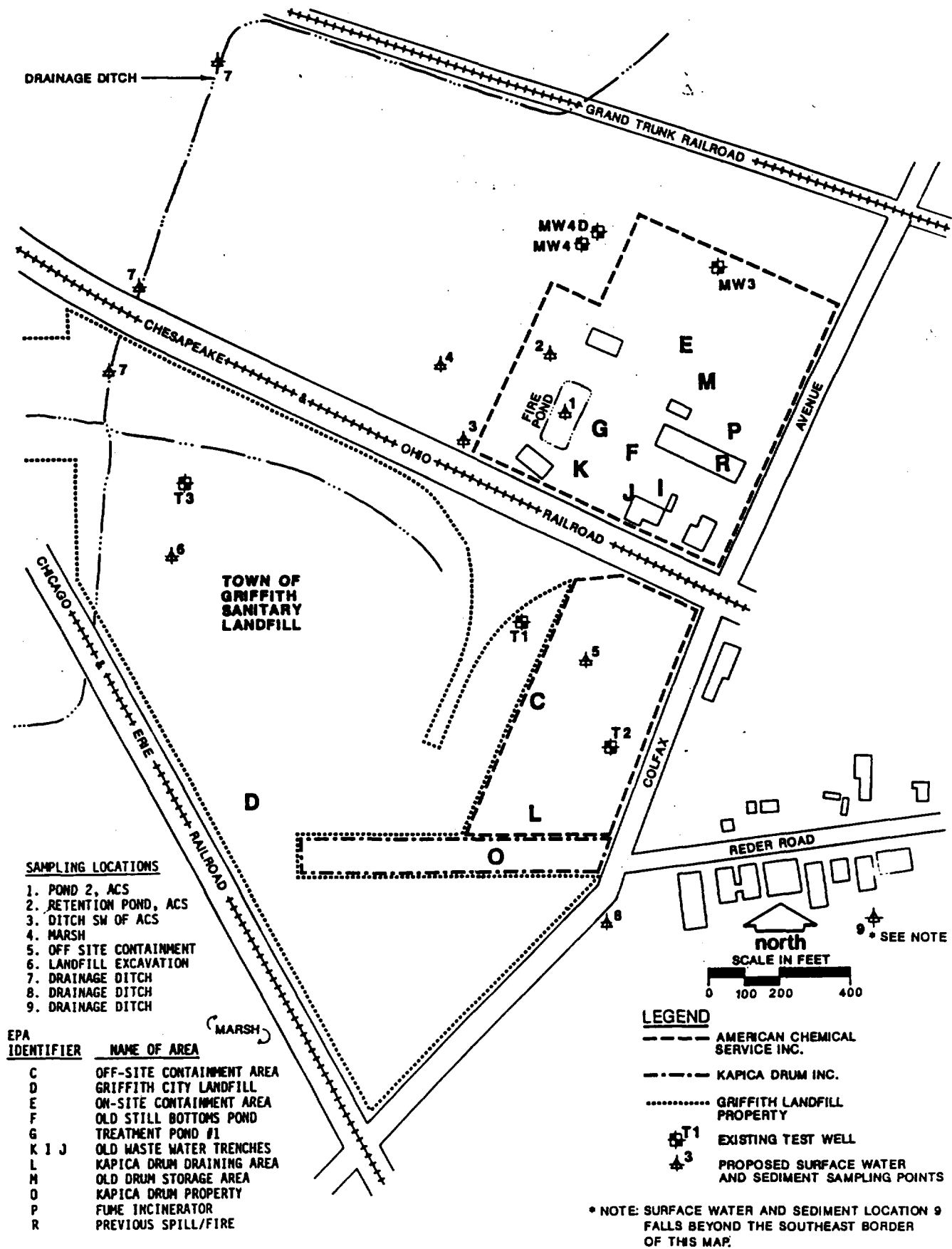



FIGURE 4-3

 60251-B4 <small>Project Number</small>	PROPOSED SURFACE WATER & SEDIMENT SAMPLING LOCATIONS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AMERICAN CHEMICAL SERVICES SITE GRIFFITH, INDIANA	WARZYN <small>WARZYN ENGINEERING INC. 1000 N. WASHINGTON NORTH ANDREWS NORTH ANDREWS</small>	Designed By _____ Drawn By <u>SR</u> Checked By _____ Approved By _____ Date _____ Scale <u>AS SHOWN</u> Remarks _____
	<small>© 2001 - Warzyn Engineering Inc. - All Rights Reserved</small>		
	<small>11/01/01</small>		
	<small>11/01/01</small>		

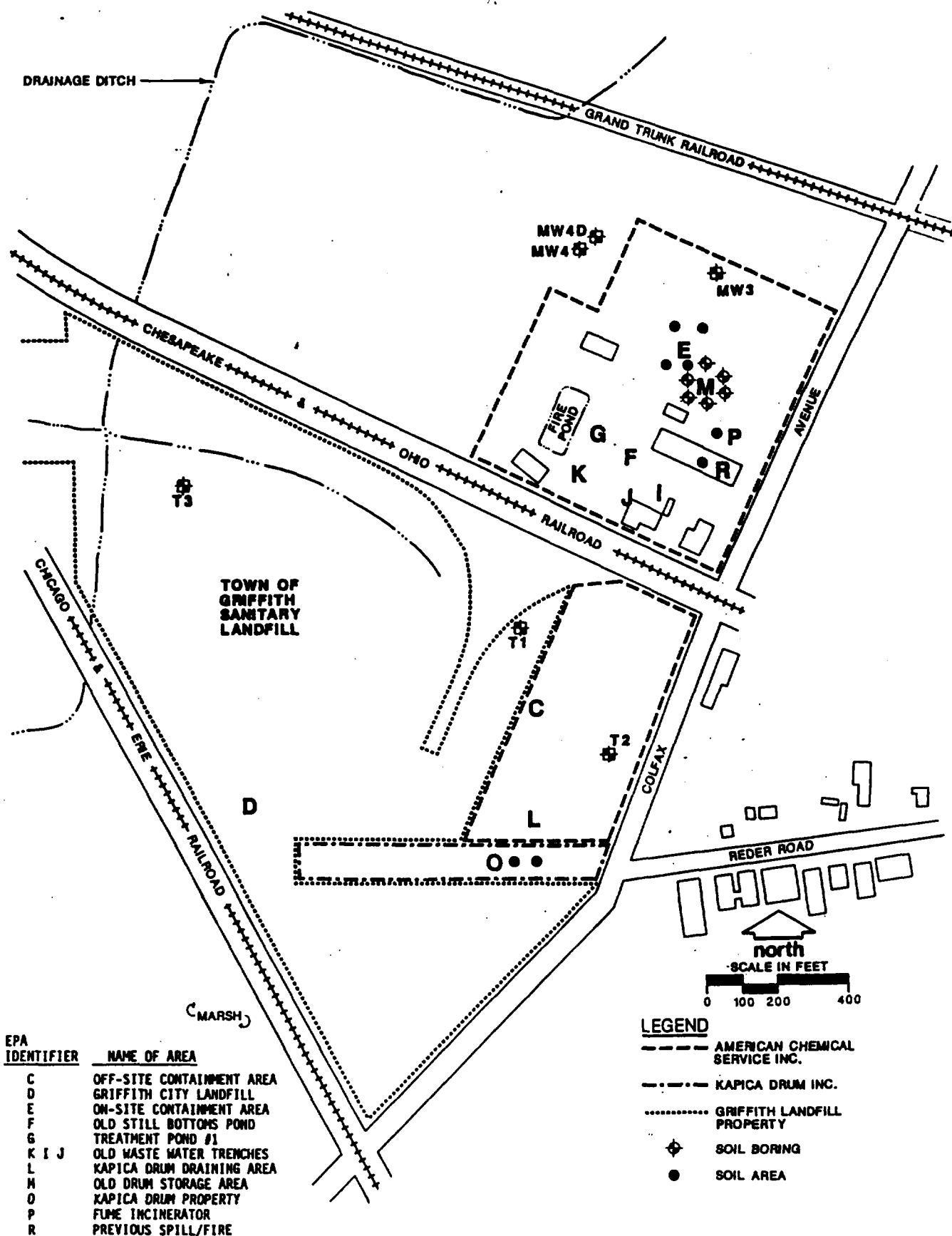
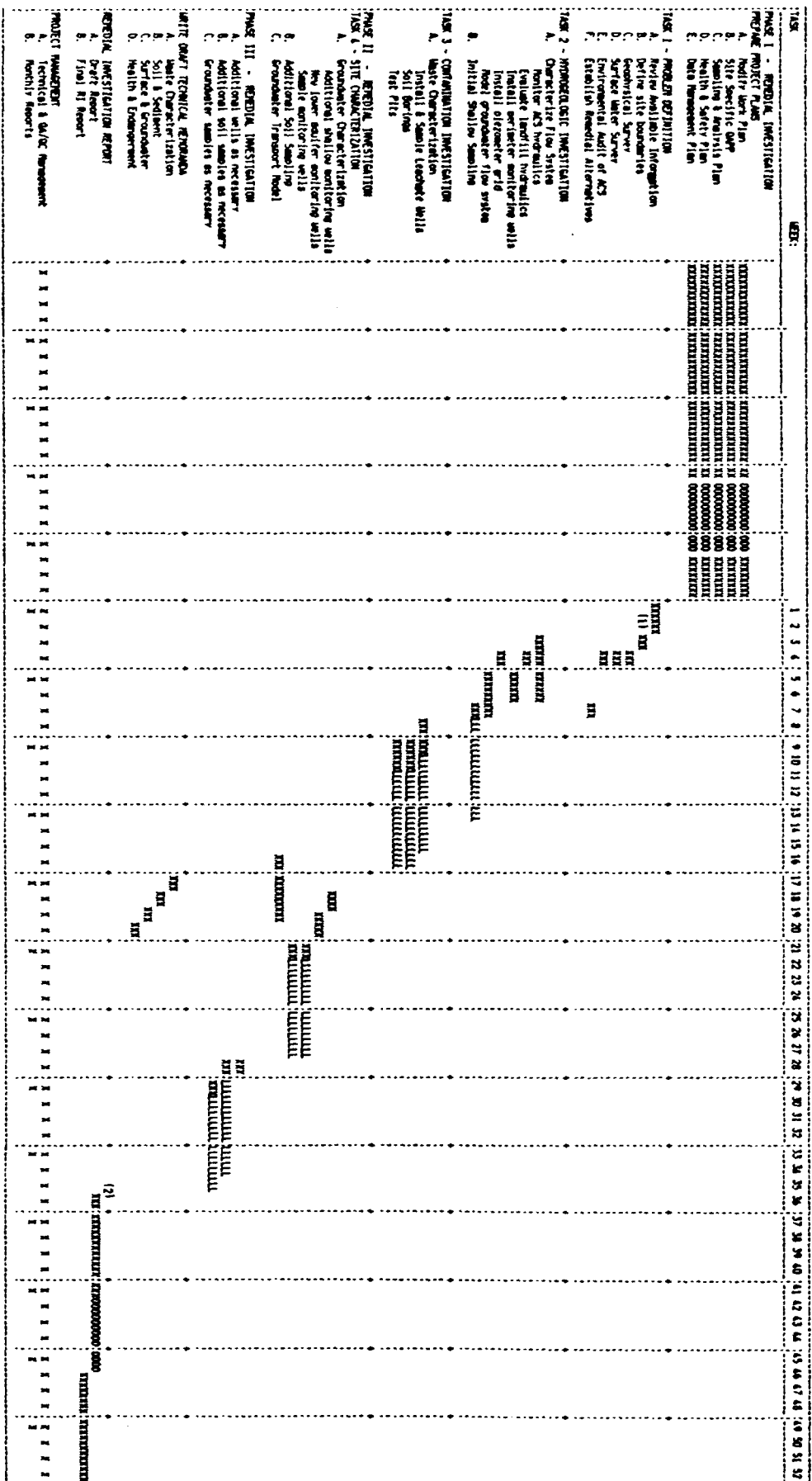


FIGURE 4-5

 60251-86	SOIL BORING & SOIL AREA LOCATIONS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AMERICAN CHEMICAL SERVICES SITE GRIFFITH, INDIANA	WARZYN <small>WARZYN ENGINEERING INC.</small> <small>Indianapolis • Chicago</small>	Designed By: <i>SR</i> Approved By: <i>SR</i> Scale: AS SHOWN	Checked By: <i>SR</i> Date: <i>SR</i> Reviewed: <i>SR</i>
	<small>© 1987 - Warzyn Engineering Inc. - All Rights Reserved</small>			

FIGURE 6-1A
PROPOSED REMEDIAL INVESTIGATION SCHEDULE
 MEDICAL CHEMICAL SERVICES
 08/17/78, 1801AM



LEGEND

PHASE I - REMEDIAL INVESTIGATION

PHASE II - REMEDIAL INVESTIGATION

PHASE III - REMEDIAL INVESTIGATION

PROJECT MANAGEMENT

(1) Task I, B, defining site boundaries, cannot be completed without authorization of site access from American Chemical Services.

(2) Draft RI will be submitted 10 weeks after completion of Phase II, which will be contingent upon the findings from Phase I.

[illegible]

XXX LAYOUT
OOO REVIEW AND COMMENT BY EPA
PPP PUBLIC HEARING

APPENDIX B
SAMPLING PLAN
FOR
AMERICAN CHEMICAL SERVICES, INC.
GRIFFITH, INDIANA
RI/FS

Prepared by:
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- 4 Summary of Phase I Source Characterization Sampling and Analysis Program
- 5 Summary of Site Characterization Sampling and Analysis Program
- 6 Organic Parameter CLP Target Compound List
- 7 Inorganic Parameters CLP Target Compound List
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- 4 Waste Pit and Boring Locations
- 5 Chain-of-Custody Record
- 6 Chain of Custody Seal
- 7 Sample Label
- 8 Sample Identification Record

**SAMPLING PLAN
AMERICAN CHEMICAL SERVICES, INC.
RI/FS**

1.0 OBJECTIVES

The primary objective of the sampling activities described below is to obtain representative data to be used for the Remedial Investigation/Feasibility Study (RI/FS) analysis. Sampling activities described in this plan will be performed to complete the Site Investigation subtasks of the RI.

Data use objectives of the Site Investigation subtask include:

- Evaluate the details of on-site soil stratigraphy and the stratigraphy in adjacent off-site areas
- Determine the hydrogeologic conditions in the upper aquifer, including vertical and horizontal groundwater flow conditions on-site and in adjacent off-site areas.
- Determine the configuration of the water table in the upper aquifer on-site and in adjacent areas off-site.
- Identify surficial drainage features and flow patterns, and characterize the relationship of surface water to groundwater on-site and in adjacent off-site areas.
- Characterize the extent of surface water and sediment contamination on-site and in adjacent off-site areas.

2.0 SCOPE

The RI will be conducted in three phases in order to make optimal use of the information as it is derived and to produce the information necessary to complete the FS. The phased approach allows "mid-course" corrections to be made so that the investigation will develop in the most efficient and cost-effective sequence. This sampling plan addresses the first two phases. Additional phases would be developed if and when it were determined that additional information would be required. Phase I includes three major tasks: Problem Definition, Hydrogeologic Investigation, and Near Surface Contamination Investigation. The major task under Phase II is Site Characterization. Additional tasks which may be performed under Phase III are Additional Contamination Investigation and Endangerment Assessment. Review the work plan for specific details.

This Sampling Plan describes the procedures and practices to be used in obtaining Site Investigation data for use in the RI/FS. These procedures include a description of the sample designation system, personnel and their responsibilities, and the sampling methods to be employed. These methods include:

- Soil borings and soil sampling
- Shallow piezometer installation
- Monitoring well installation
- Geophysical Survey
- Leachate well installation
- Groundwater sampling
- Leachate sampling
- Surface water and sediment sampling
- Water level monitoring in piezometers and surface water
- Aquifer tests
- Private well sampling
- Test pits

3.0 SAMPLING LOCATIONS AND NUMBER OF SAMPLES

3.1 HYDROGEOLOGIC INVESTIGATION

The hydrogeologic investigation will include groundwater sampling, water level measurements, aquifer tests, continuously sampled and logged borings, well installations, and piezometer installations.

3.1.1 Groundwater Sampling

One round of groundwater samples will be obtained during Phase I from each of the 6 perimeter wells. The locations proposed for these wells are depicted on Figure 1.

During Phase II of the investigation, two rounds of groundwater samples will be obtained from all of the Phase I perimeter wells, and from all of the wells installed during Phase II. It is anticipated that 8 to 12 wells may be installed during Phase II. During the second round, it is anticipated that only 9 wells will be sampled for the complete TCL, and the remaining number sampled for a reduced parameter test approved by the U.S. EPA.

Off-site, one upgradient and nine downgradient private water supply wells will be sampled during Phase II. The locations of the known private wells are shown on Figure 2. The specific wells to be sampled will be identified based on the results of the Phase I study.

3.1.2 Water Level Measurements

Water levels will be measured at least twice during the Phase I field effort and at least once during the Phase II field effort. Measurements will be obtained from each of the shallow piezometers and each of the surface water locations depicted in Figure 1. The first set of measurements will be made within a week after installations are completed for both the piezometers and the surface water reference locations. If possible, measurements will also be made during dry and wet periods. Also, immediately after a major precipitation event, closely-spaced measurements may be made to determine the response of the system to such an occurrence.

3.1.3 Aquifer Tests

Slug tests will be conducted in three of the six new Phase I wells to determine the hydraulic properties of the upper aquifer. A total of eight slug tests will be conducted during Phase II. All of the four lower aquifer wells will be tested, and four of the Phase II shallow aquifer wells will be tested.

The wells to be used in the aquifer testing will be those best representing the aquifers. Criteria for selection will include saturated thickness and grain size. If indicated, a pumping test might be conducted. In addition, up to 90 laboratory geotechnical tests will be performed on aquifer and aquitard materials. These tests will include hydraulic conductivity, grain size, Atterberg limits, cation exchange capacity, and moisture content.

3.1.4 Monitoring Well Installations

Six wells will be installed during Phase I at the locations shown in Figure 1. These wells will be completed with the ten-foot screen intersecting the water table in the upper aquifer.

It is anticipated that eight to twelve wells will be installed during Phase II. Four wells will be screened in the upper aquifer and the remaining number in the upper part of the lower aquifer. The screen locations for the Phase II upper aquifer wells will be determined based on the Phase I results, as will the horizontal locations of all the wells.

3.1.5 Piezometer Installation

Piezometers, designed to only collect water level data, will be installed at approximately 40 locations as depicted in Figure 1, during Phase I. Piezometers will be located throughout the site including in the landfill. Under no circumstances would piezometers be installed through the base of the landfill. Piezometer screens will intersect the top of the first saturated layer.

3.2 CONTAMINANT INVESTIGATION

The Phase I Contaminant Investigation will involve sampling of the surface soil, the drilling of 14 soil and waste borings, a geophysical survey, surface water and sediment sampling and excavation of 6 waste test pits. A total of 48 investigative samples will be submitted for analysis (Table 2).

Four leachate wells will be installed and sampled during Phase I. Sampling of the ACS effluent may also be done at selected locations. It is anticipated that additional drilling, sampling, and analysis will be conducted under Phase II with up to 20 samples collected for analysis. The locations will be determined based on Phase I results.

3.2.1 Surficial Soil Area Sampling

The On-Site Containment Area will be divided into four sampling areas, and the former Kapica Drum property will be divided into two sampling areas. Within each of these areas, a soil sample will be collected at the depth interval of 6-18 inches at five discrete locations and then composited (volatile organic samples will be grab only) for a total of 6 samples. One grab sample will be collected near the former fume incinerator, and one grab sample at the site of a previous spill/fire. These samples will also be collected from the 6 to 18 inch depth interval. The approximate locations for these eight investigative samples are shown in Figure 3.

3.2.2 Geophysical Survey

A field test will be conducted to determine if a magnetometer survey will provide meaningful data. Because of the presence of railroads, power lines, metal buildings, metal process tanks, geophysical methods may be of limited utility. If feasible, the method would be used to located buried drums in the ACS Off-Site Containment Area, On-Site Containment Area, Old Still Bottoms Pond, Treatment Pond No. 1, and the Kapica Drum draining area.

3.2.3 Test Pits

Six waste test pits will be excavated at approximately the locations identified in Figure 4. These are the On-site Drum Containment Area, the Still Bottoms Pond and Treatment Pond No. 1. If a liner is encountered, excavation will cease. In each test pit one composite waste sample (volatile organic samples will be grab only), consisting of five discrete samples, and one natural subsoil sample will be collected.

3.2.4 Soil and Waste Borings

Five waste borings will be drilled in the Off-Site Drum Containment Area with one composite waste sample (volatile organic samples will be grab only), consisting of five discrete samples, and one natural soil sample being collected from each boring. Three borings are planned for the Kapica Drum site with one composite waste sample and one natural subsoil sample collected from each boring. The approximate locations of these eight borings are located in Figure 4.

Six soil borings will be drilled in the Old Drum Storage Area. Two grab samples will be collected from each boring at the depth intervals of 2 to 2.5 feet and 4 to 4.5 feet, for a total of 12 samples submitted for analysis. The approximate locations of these borings are depicted in Figure 3.

3.2.5 Leachate Well Installation and Sampling

Four leachate wells will be installed approximately as shown in Figure 1. The borings for the wells will not penetrate the base of the landfill. One round of samples will be collected during Phase I.

3.2.6 Surface Water and Sediment Sampling

A surface water and sediment sample will be collected from each of the 11 locations shown in Figure 1. Sampling locations include: Treatment Pond No. 2, the ACS Retention Pond, a drainage ditch at the southwest corner of the ACS plant, the marsh, ponded water near the Off-Site Drum Containment Area, the Griffith Landfill excavation, three sites along a drainage ditch connecting the marsh to Turkey Creek, a drainage ditch that is parallel to Colfax Avenue south of intersection of Colfax Avenue and Reder Road, and a drainage ditch 1,800 feet southeast of the ACS site (beyond limits of Figure 1).

3.2.7 Effluent Sampling

It is anticipated that sampling of ACS waste effluent will be performed. Up to four samples will be collected at locations to be determined based on results of the ACS Environmental Audit.

4.0 SAMPLE DESIGNATION

A sample numbering system will be used to identify each investigative and quality control sample. Each sample identifier will include the project identifier code, sample type and location code, and a sampling event code. The sampler will maintain a log book containing the sample identification listings.

4.1 PROJECT IDENTIFIER CODE

A 3-letter designation will be implemented to identify the sampling site. The project identifier will be "ACS" to signify this site investigation.

4.2 SAMPLE TYPE AND LOCATION CODE

Each sample location will be identified by a 2-letter code corresponding to the sample type. Sample type codes to be utilized for the subtasks covered in this Sampling Plan include:

- GW - groundwater sample from monitoring well
- LE - leachate sample
- SS - split spoon or soil boring sample
- SD - sediment sample
- SW - surface water sample
- PW - groundwater from a private well
- WP - waste sample from test pit
- NP - soil sample from test pit
- AE - ACS effluent sample
- WB - waste boring sample
- NB - natural soil boring sample
- SA - soil area sample
- SB - soil boring sample
- FB - field blank
- TB - trip blank
- MS(D) - matrix spike (duplicate)

Other letter designators may be added for sample activities of later subtasks.

The location code will follow the sample type code. The location code consists of a two- to five-digit numeric or alpha-numeric code that indicates the sample location. Surface water, sediment, field blanks, and trip blanks will use a consecutive numbering system, starting at 01, assigned in the field.

4.3 SAMPLING ROUND CODE/DUPLICATE CODE

A two-digit numerical code will be used to designate additional information. The round code will indicate the groundwater sampling round. Duplicate samples will be designated by the round code preceded by a 9. For boring samples, the round code will represent the depth of the sample in feet below the ground surface.

4.4 EXAMPLES OF SAMPLE NUMBERS

Examples of sample number codes are as follows:

- ACS-SSMW03A-25 = ACS, split spoon sample from Monitoring Well MW03A at a depth of 25 feet
- ACS-GMMW03A-01 = ACS, groundwater sample from Monitoring Well MW03A, first sampling round
- ACS-GMMW03A-91 = ACS, duplicate groundwater sample from Monitoring Well MW03A, first sampling round
- ACS-SD10-01 = ACS, sediment sample from location number 10, first sampling round

5.0 SAMPLING EQUIPMENT AND PROCEDURES

5.1 GROUNDWATER SAMPLING

5.1.1 Monitoring Wells

Groundwater sampling will proceed from wells thought to have the lowest contaminant concentrations to wells suspected to have the highest contaminant concentrations. A clean work area will be set up at the well before sampling begins at that well. Prior to purging the well, a water level measurement will be made using an electronic water level indicator or a tape with a sounding device. Total depth of the well will also be measured. The reference point for these measurements is the top of the inner well casing (when protective casing present). Measurements will be made to the nearest 0.01 foot and recorded in the field notebook along with the purge volume.

Each well will be purged immediately prior to sampling, using a submersible bladder pump. The pump will be constructed of stainless steel and teflon. Dedicated teflon tubing will be used to purge and sample each well. The volume of water removed shall be measured using a calibrated bucket to ensure that a minimum of three well volumes are removed. The pH, specific conductance and temperature will be measured to determine that these parameters have stabilized prior to sample collection. The conductivity meter will be zeroed according to the procedures specified by the manufacturer prior to measurement. Buffer solutions will be used to calibrate the pH meter and conductivity meter at the beginning of each day and after every ten samples. A sample of water will be placed into a beaker into which the probes are inserted. After the readings are made, the water sample is then added to the collected purge water. Purge water will be collected and containerized.

After well purging is completed, the discharge of the pump will be reduced to 100 ml/min or less to fill the sample containers. Sample containers shall be filled in the following order: volatiles, semi-volatile, PCB/pesticides, total organic carbon, metals, cyanide, sulfate-chloride-alkalinity, ammonia-nitrate-nitrite, and total suspended solids-total dissolved solids.

For volatile organic analysis (VOA) samples, the preservative shall be added to the vial prior to collecting the sample. The VOA sample vial will be carefully filled until the proper meniscus forms. The cap shall be carefully placed on the vial, after which the vial will be inverted to inspect for air

bubbles. If air bubbles are present, the cap will be removed and more sample will be added. The cap will be replaced and inspected again for bubbles. Repeat if necessary.

The remainder of the sample bottles will then be filled in the order outlined above according to the specifications listed in Table 3. Groundwater samples requiring field filtering will be filtered using a positive-pressure filtration device. After filtering is completed, preservative may be added to those sample containers as specified in Table 3. The pH of the preserved sample shall be tested by pouring a small amount of sample into a watch glass or beaker and then testing the aliquot with pH paper (except VOA which will not be disturbed). Samples will be iced immediately after collection.

Duplicate samples will be prepared by alternatively filling each vial or bottle (i.e. one investigative sample vial or bottle), then one duplicate sample vial or bottle, etc.).

The trip blank will consist of two 40-ml VOA vials filled with deionized water and preservative at the laboratory or office, transported to the field and shipped to the laboratory with the investigative VOA vials. The vial will not be opened in the field and will be handled and documented using the standard procedures.

Field blanks will be prepared by pumping deionized water through the bladder pump and tubing and filling the sample containers in the same manner as for investigative samples. The field blank for constituents requiring filtering shall require the additional step of passing the aliquot through the field filtering apparatus.

The semi-volatile organics matrix spike/matrix spike duplicate (MS/MSD) for water samples must be collected at double the volume normally required. The PCB/Pesticide MS/MSD for water samples must also be collected at double the volume normally required and the volatile sample MS/MSD must be collected at triple the normal volume.

The sampling equipment shall be cleaned and handled between wells following the procedures outlined in Section 6.

5.1.2 Private Water Supply Well

It is anticipated that these wells will be in constant use and so the purge volume will be limited to that volume between the well head and sampling point. Temperature, pH, and conductivity shall also be monitored to determine stabilization of these parameters. The sampling point will be as close as possible to the well head, before any treatment occurs (i.e. water softeners, filters, etc.). The sampling port may require cleaning prior to purging and sampling. After purging, reduce the discharge rate and follow the same collection and handling procedures outlined under 4.1.1 for groundwater samples. The field blank will be prepared by pouring deionized water directly into the sample containers. The trip blank will be prepared as described in 5.1.1. Water samples will not be filtered. These private water supply samples will be analyzed by different methods with lower detection limits. See Appendices C and D of QAPP for methods and detection limits.

5.1.3 Water Level Measurements

Water level measurements will be obtained from the shallow piezometer system, and monitoring wells, using an electronic water level indicator or a tape and sounding device. The measurement shall be made to the nearest 0.01 foot. The reference point shall be the top of the inner casing. If the top of the inner casing is not level, the reference point will be the highest side of the casing.

5.2 AQUIFER TESTING

5.2.1 Field Testing

The hydraulic conductivity of the penetrated aquifer will be estimated by conducting slug tests. The basic concept behind these tests is that the rate of rise or fall of the water level in a well after "instantaneous" displacement of a "slug" of water is a function of aquifer hydraulic conductivity.

Hydraulic conductivity testing will be performed as follows:

- An initial measurement of static water level will be made.
- A volume of water will then be displaced as rapidly as possible using a calibrated solid cylinder or compressed air. Highly permeable conditions ($K > 10^{-3}$ cm/sec) are anticipated.

- Water level changes in the well will be sensed and recorded by a pressure transducer connected to an electronic data logger. Water level measurements will be collected automatically on logarithmically increasing time steps, starting at 0.003 minutes (i.e., the first 10 measurements will be taken at the following elapsed time: 0, 0.003, 0.007, 0.010, 0.013, 0.017, 0.020, 0.0233, 0.026, 0.030). The total test time could last from several minutes to several hours for each well.
- The data will be plotted in the field (water level vs. log time) using semi-log paper to determine if the data are sufficient to establish a reasonable straight-line relationship.

Analysis of test data should use appropriate computational methods such as that presented by Bouwer, H. and R.C. Rice, 1977, "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells," Water Resources Research, Vol, 12, No. 3, pp. 423-428, or Nguyen, V., and G. F. Pinder, 1984, "Direct Calculation of Aquifer Parameters in a Slug Test Analysis", Groundwater Hydraulics, Water Resources Monograph No. 9, American Geophysical Union, pp. 222-240. If indicated, a pumping test might be conducted.

5.2.2 Laboratory Testing

Samples will be collected in 3-inch diameter Shelby tubes, capped, taped to seal and stored at 4 degrees centigrade until analyzed. Samples expected to have a saturated hydraulic conductivity of 1×10^{-3} cm/sec or less will be tested using a falling head test and those expected to be greater than 1×10^{-3} cm/sec will be tested using a constant head test, using a flexible wall permeameter.

Grain size analysis will be accomplished using ASTM Methods D421, D422, and D2217. Samples for grain size analysis will be collected from split-spoon samplers and placed into glass jars. Soil samples will also be tested for Atterberg limits, cation exchange capacity and moisture content.

5.3 MONITORING WELL INSTALLATION

Borings will be drilled using a 4 1/4-inch ID hollow stem auger. Formation samples will be collected continuously from the surface to the end of the borehole. Split-spoon (ASTM D1586-84) formation samples will be visually classified in the field by a geologist. Representative samples of units

encountered will be placed into glass jars for laboratory analysis. Three-inch ID Shelby tube samples (ASTM D1587) will also be collected for laboratory hydraulic conductivity testing of the units encountered. These samples will be handled and stored as described above (Section 5.2.2).

Drilling equipment and tools will be decontaminated between boreholes as outlined in Section 6. Well casing and screens will be cleaned and stored as outlined in Section 6. Well casing and screen will be constructed of 2-inch ID threaded flush-joint stainless steel 316 and will have vented locking caps. Ten foot screens with 0.01-inch openings and a No. 30 flint sand or natural cave-in will be used for the sand pack.

Because Phase I and II upper aquifer wells are expected to be screened at shallow depths in coarse grained deposits, a surface seal will be unnecessary. Phase II lower aquifer wells will be constructed using a telescoping casing. The outer casing will be set 5-feet into the aquitard and sealed. Split-spoon samples (ASTM D1586-84) will be obtained every five feet in the upper aquifer and continuously through the aquitard and lower aquifer to the end of the borehole. The screen of the inner casing will be set 12 feet into the lower aquifer. Two-foot bentonite seal will be placed 2-feet above the screen and then the annular space will be filled with bentonite grout to within three-feet of the surface. The remainder will be filled with cement-bentonite grout.

A concrete apron will be placed around each well. All wells will be developed using a surge block and/or pumping. Well casing elevation will be surveyed to the accuracy of ± 0.01 foot, and ground elevation and horizontal location will be surveyed to the accuracy of ± 0.1 foot. Well casings will be permanently marked with the well number.

5.4 PIEZOMETER INSTALLATION

The piezometers will be installed by jetting them into the ground. The piezometers placed within the landfill may have to be installed with a drill rig. Screens for the piezometers will be set at the top of the first saturated layer. Caps will be pop-riveted in place to seal the piezometer and avoid tampering. Piezometer casing elevation will be surveyed to the accuracy of ± 0.01 foot, and ground surface elevation and horizontal location will be surveyed to the accuracy of 1.0 foot. Piezometers will be permanently marked with the piezometer number.

5.5 SURFICIAL SOIL SAMPLING

A hand-auger or shovel will be used to remove the upper six inches of material. The bucket auger will then be inserted into the hole and the sample brought to surface and placed into a stainless steel pan. This is repeated to obtain sample from the 6 to 18 inch depth interval.

Grab samples will be placed into the sample containers with a stainless steel scoop. Composite samples (except volatiles) will be obtained by homogenizing the subsamples in the stainless steel pan with a scoop or trowel. A sample will then be placed into the appropriate sample containers. Samples for volatile organic parameters will be grab samples selected from the five discrete samples from each sampling area on the basis of HNu results and/or other evidence of contamination (e.g. visual). One duplicate sample will be collected. No blanks will be prepared. Equipment and tools will be decontaminated as outlined in Section 6.

5.6 GEOPHYSICAL SURVEY

A feasibility test will be conducted to determine if the magnetometer will provide meaningful data. The instrument will be calibrated according to the manufacturer's instructions. Anomalous areas will be marked by pin flags in the field. Selected points will be duplicated to examine equipment response. If response is inconsistent, data will be considered unusable.

5.7 TEST PITS

Waste test pits will be excavated with a backhoe. The backhoe operator will remain in the cab during all excavation activities and be prepared to fill the pit quickly in the event of an emergency. Excavated materials will be placed on the downwind end of the pit for inspection. All pits will be filled prior to starting a new excavation and at the end of each work day. No pit will be left open and unattended at any time. Personnel will not enter test pits. Pits will be marked to enable future location. Samples will be taken from representative layers of waste and then composited (except volatiles). The excavation will extend at least one foot into natural subsoils. A sample of the natural subsoil will be obtained. Hand tools will be used to collect samples. Composite samples will be prepared in the field. Samples for volatile organics will be grab samples selected from one of the five discrete samples on the basis of HNu results and/or other evidence of

contamination (e.g. visual). The material excavated will be used as backfill for the test pit. Samples will be placed into the appropriate containers. No blanks will be prepared. One natural soil and one waste duplicate sample will be collected.

5.8 SOIL AND WASTE BORINGS

Waste borings will be continuously sampled with a split-spoon (ASTM D1586-84) to a depth of approximately 1 1/2 feet below the waste. Waste samples will be homogenized in a stainless steel pan with hand tools and a representative sample placed into the appropriate containers (except volatiles). Samples for volatile organics will be grab samples selected from one of the five discrete samples on the basis of HNu results and/or other evidence of contamination (e.g. visual). A 1-foot grab sample of the natural subsoil will be obtained from each boring using the split-spoon.

Soil borings will be advanced to a depth of two feet, below which a 6-inch split spoon sample will be obtained. The auger will be advanced to a depth of 4 feet and another sample obtained from the interval 4 to 4.5 feet. Each of these 6-inch samples will be a grab sample.

Samples will be placed in the appropriate containers and boreholes will be filled with bentonite grout to the surface. All drilling equipment and tools will be cleaned between sampling locations according to procedures in Section 6.

5.9 LEACHATE WELL INSTALLATION AND SAMPLING

A hollow-stem auger will be used to advance the borehole up to 15 feet below the first saturated zone encountered; in no event shall any liner present be penetrated. The entire saturated zone penetrated shall be screened using threaded flush-joint PVC with PVC riser pipe to the surface. The screen openings shall be 0.01 inch with a No. 30 flint sand (or equivalent) filter. The filter shall extend to 2-feet above the screen, above which a two-foot bentonite pellet seal will be placed. The remaining annular space to within 3-feet of the surface will be filled with bentonite grout. A concrete seal will then be placed to the surface, forming an apron at the surface. Concrete barrier posts shall be placed around the concrete apron.

The well shall be developed and sampled using a stainless steel bailer. All purge and development water shall be collected and containerized. Sampling

will be conducted as for the groundwater wells under 5.1.1 except that a bailer will be used. Trip blanks will be prepared as described in 5.1.1. The field blank will be prepared by pouring deionized water into a clean bailer and filling sample bottles in the same manner as for an investigative sample. The drilling and sampling equipment shall be cleaned and stored between wells using the procedures outlined in Section 6.

5.10 SEDIMENT AND WATER SAMPLING

The surface water grab sample will be collected prior to collecting the sediment (grab) sample at a given location. Where appropriate, the samples will be taken from the most distal downstream location to the furthest upstream location. Samples will be obtained with stainless steel equipment which will be decontaminated between sample locations using the procedures outlined in Section 6. A bucket auger will be used to collect a sample from the depth interval 0 to 6 inches. Samples will be placed into the appropriate containers. Duplicates will be collected for both sediment and water samples, but field blanks will only be prepared for water samples. Water samples will not be filtered. Trip blanks will be prepared as outlined under 5.1.1.

5.11 EFFLUENT SAMPLING

This effort will be designed after the Environmental Audit of ACS.

5.12 PERSONNEL AND RESPONSIBILITIES

All personnel working at the ACS site on the RI will have been trained in health and safety matters relating to hazardous waste site investigations. Efforts will be made to use the same personnel throughout the course of the field work to optimize familiarity with site conditions. The boundary survey will be done by an Indiana licensed land surveyor. All other surveys will be conducted by a two-person team.

A two-person drilling crew and two field technicians will be supervised by a geologist or engineer. The geologist or engineer will also serve as the Safety Officer. A geologist will conduct the slug tests and log the soil samples. Samples will be collected by or under the supervision of the geologist in the various media: groundwater, surface water, leachate and waste. Also water levels will be collected by the geologist or engineer, and a field technician. An earth moving subcontractor will operate the backhoe.

6.0 DECONTAMINATION PROCEDURES

Procedures to be followed to decontaminate equipment and personnel are described in the Site Health and Safety Plan. The procedures are summarized below.

Site Personnel Decontamination Procedure:

- Dispose of outer latex booties
- Wash boots in TSP bootwash
- Clean outer gloves in TSP wash solution (discard if too soiled to clean thoroughly)
- Dispose of polycoated tyvek suits
- Dispose of surgical gloves
- Wash hands in hand wash
- Wash face and neck in face wash
- Clean and sanitize face mask

Site personnel will perform the above mentioned decontamination procedure prior to leaving the site. Personnel will shower immediately after arriving at their residences.

Discarded clothing and other articles will be collected in double-lined, heavy duty garbage bags.

Equipment and vehicle decontamination procedure:

- Decontamination will be performed prior to site entry
- Decontamination will be performed on-site
- Gross contamination will be removed with a brush and TSP solution
- Steam cleaning will follow

The drilling equipment and the backhoe will be steam cleaned prior to exiting the site at an area designated for equipment and vehicle decontamination. Another area, located away from the equipment decon area, will be designated as a site personnel decon area.

Decontamination will include steam cleaning the drilling equipment, backhoe and tools between boreholes and test pits, and detergent washing and deionized water rinsing the split spoon samplers after each collected sample.

Well casing and screens will also be steam cleaned and wrapped in plastic until installed. Sampling equipment such as the bailer cable, trowels, spatulas, stainless steel bucket, pump, bailer, etc. will be cleaned with a trisodium phosphate (TSP) detergent solution, and rinsed with deionized water between sampling locations and stored to prevent contamination before use.

Equipment remaining at the site may not be decontaminated, but will be stored on the contaminated side of the equipment and vehicle decon area at the end of each work day.

7.0 SAMPLE HANDLING AND ANALYSIS

7.1 PARAMETERS

Samples to be analyzed for TCL organics (both standard CLP detection limit, and low detection limit) will be sent to Hazleton Laboratories America, Inc. Samples to be analyzed for TCL metals, cyanide, and indicator parameters will be sent to Warzyn Engineering Inc. (for both standard CLP detection limit and low detection limit). Samples to be analyzed for geotechnical parameter will be sent to Warzyn Engineering Inc. Parameters for which groundwater, surface water, private water supply wells, soil, sediment, ACS effluent and waste are to be analyzed are summarized in Tables 4, 5, 6, 7 and 8.

Measurement of pH, specific conductance and temperature will be performed in the field as will vapor screening with OVA or HNu.

7.2 SAMPLE PRESERVATION

Samples will be collected and preserved in a manner appropriate for the analyses they receive (Table 3). The portion of groundwater samples requiring field filtering prior to analysis (Table 3) will be filtered using a pressure filtration device, through a 0.45 micron filter, as soon as possible after collection. Filtered portions of the samples will be preserved, as appropriate, immediately after filtration. Sample fractions will be preserved before shipment according to the procedures shown in Table 3. Preservatives added to the samples will be prepared using reagent grade chemicals.

8.0 SAMPLE DOCUMENTATION

Samples will be collected under chain-of-custody procedures. Standard forms including sample labels, sample tags, chain-of-custody forms, and custody seals used for sample tracking will be maintained. A brief description of sample documents follow:

A. Chain-of-Custody Form (Figure 5)

1. One Form per shipping container (cooler).
2. Carrier service does not need to sign form, if custody seals remain intact.
3. Use for all samples

B. Chain-of-Custody Seals (Figure 6)

1. Two seals per shipping container to secure the lid and provide evidence that samples have not been tampered with.
2. Cover seals with clear tape.
3. Record seal numbers on Chain-of-Custody Form.
4. Use for all samples.

C. Sample Tags (Figure 7)

1. Each sample container must have a sample tag affixed to it.
2. Sample tag numbers are recorded on the Chain-of-Custody Forms.
3. Use for all samples.

D. Sample Identification Record Form (Figure 8) will:

1. Provide means of recording crucial sample shipping and tracking information.
2. Contain information such as:
 - Sample number
 - Sample matrix
 - Sample location code
 - Sample round

- Chain-of-custody number
- Lab code
- Date sampled
- Date shipped
- Airbill number
- Sampling tag number

Paperwork accompanying the samples being shipped to the laboratory will be sealed in a plastic bag that is taped to the inside of the cooler lid. Copies of the chain-of-custody forms, and other paperwork (if possible), will be retained for the field files.

Two sample seals will be placed on opposite sides of the lid and extending down the sides of the cooler. The lid will be securely taped shut prior to shipment.

Representative photographs will be taken of sampling stations to show surrounding area and used to locate the station. The picture number and roll number will be logged in the field log book to identify which sampling site is depicted in the photograph. The film roll number will be identified by taking a photograph of an informational sign on the first frame of the roll. This sign would have the job and film roll number written on it so as to identify the pictures contained on the roll.

For example:

American Chemical Services
Roll Number 1
Frame Number 1 of 36
1 Nov 1988

All sampling documentation will be maintained in Warzyn files as outlined in the QAPP.



TABLE 1
SITE CHARACTERIZATION SAMPLING EFFORT

	<u>INVESTIGATIVE</u>	<u>DUPLICATE</u>	<u>FIELD BLANKS</u>
Groundwater (GW)			
Phase I	6	1	1
Phase II A (up to)	12	2	2
Phase II B (up to) full TCL	9	1	1
*Phase II B (up to) reduced parameter list	(9)	(1)	(1)
Surface Water (SW)	11	2	2
Sediment (SD)	11	2	0
Private Wells (PW)	10	1	1
Leachate (LE)	4	1	1
ACS Effluent (AE)	4	1	1
	<hr/>	<hr/>	<hr/>
SUBTOTAL	67	11	9
Chemical Subtotal	87		
Geotechnical	90		
Geotechnical Subtotal	90		

TOTAL: 177

Note:

* Numbers not included in total

TABLE 2
SOURCE CHARACTERIZATION SAMPLING EFFORT

	<u>INVESTIGATIVE</u>	<u>DUPLICATE</u>	<u>FIELD BLANKS</u>
<u>PHASE I</u>			
Waste Pit (WP)	6	1	0
Natural Soil Pit (NP)	6	1	0
Waste Boring (WB)	8	1	0
Natural Soil Boring (NB)	8	1	0
Soil Area (SA)	8	1	0
Soil Boring (SB)	12	2	0
	—	—	—
Chemical Subtotal	48	7	0
PHASE I TOTAL: 55			
<u>PHASE II</u>			
To Be Defined in Phase I	20	2	0
PHASE II TOTAL: 22			

Notes:

Blanks are not necessary for solid material samples.

TABLE 3
SAMPLE QUANTITIES, BOTTLES, PRESERVATIVES AND PACKAGING
FOR WATER, SEDIMENT AND LEACHATE SAMPLES

<u>Analysis</u>	<u>Bottles and Jars</u>	<u>Preservation</u>	<u>Holding Time</u>	<u>Volume of Sample</u>	<u>Shipping</u>	<u>Normal Packaging</u>
WATER AND LEACHATE						
<u>Low Concentration (Organics)</u>						
Semi-Volatiles	Two 1-liter amber bottle (teflon-lined cap)	Iced to 4°C	5 days until extraction, 40 days after extraction	Fill bottle to neck	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
Pesticides/PCBs	Two 1-liter amber bottle (teflon-lined caps)	Iced to 4°C	5 days until extraction, 40 days after extraction	Fill bottle to neck	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
Volatiles	Two (three for private wells) 40-ml volatile organic analysis (VOA vials)	Iced to 4°C HCL to pH <2	7 days (48 hours for surface water)	Fill completely no headspace	Shipped Daily by Overnight Carrier	No. 1 foam liner or vermiculite
<u>Low Concentration (Inorganics)</u>						
Metals (groundwater)	One 1-liter high density polyethylene bottle	Filter through 0.45 um filter, HNO ₃ to pH <2 Iced to 4°C Optional	6 months (Hg, 26 days)	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Metals (leachate, surface water and private water supply wells)	One 1-liter high density polyethylene bottle	HNO ₃ to pH <2 Iced to 4°C	28 days	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Cyanide	One 1-liter high density polyethylene bottle	NaOH to pH >12 Iced to 4°C	14 days	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
<u>Other Analysis</u>						
Chlorides, Alkalinity Sulfate	One 1-liter high density polyethylene	Iced to 4°C	28 days (14 days for alkalinity)	Fill to shoulder of bottle	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Total Organic Carbon, Ammonia, Nitrate-Nitrite, Chemical Oxygen Demand	One 1-liter polyethylene high density bottle	Iced to 4°C H ₂ SO ₄ to pH <2	28 days	Fill to shoulder	Shipped Daily by Overnight Carrier	No. 2 foam liner or vermiculite
Total Dissolved Solids Total Suspended Solids	One 1-liter polyethylene high density bottle	Iced to 4°C	7 days (filter up)	Fill to shoulder	Shipped Daily by Overnight	No. 2 foam liner or vermiculite

TABLE 3 (CONTINUED)

SOIL/SEDIMENT

Low or Med Concentration (Organics)

Acid extractables, base/neutral extractables, pesticides/PCBs	One 8-oz wide mouth glass jar	Iced to 4°C	10 days until extraction, 40 days after extraction	Fill 3/4 full	Shipped Daily by Overnight Carrier	Foam liner No. 3 (Med in cans/vermiculite)
Volatiles	Two 120-ml VOA vials	Iced to 4°C	10 days	Fill completely no headspace	Shipped Daily by Overnight Carrier	Vermiculite (Med in cans/vermiculite)

Low or Med Concentration (Inorganics)

Metals and Cyanide	One 8-oz wide mouth glass jar	Iced to 4°C	6 months (14 days for cyanide)	Fill 3/4 full	Shipped Daily by Overnight Carrier	Foam liner No. 3 (Med in cans/vermiculite)
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Physical Analyses

Grain Size, moisture content	One 8-oz wide mouth glass jar	None	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite
Atterberg Limits	One 8-oz wide mouth glass jar	None	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite
Permeability	3-in Shelby Tubes	4°C	not established	Fill 3/4 full	Shipped Daily by Overnight Carrier	Vermiculite

TABLE 4
SUMMARY OF PHASE I SOURCE CHARACTERIZATION
SAMPLING AND ANALYSIS PROGRAM

<u>Sample Matrix</u>	<u>Laboratory</u>	<u>Laboratory Parameters</u>	<u>No. of Investigative Samples</u>	<u>No. of Field Duplicates</u>	<u>No. of Matrix Spike/³ Matrix Spike Duplicates</u>	<u>Total No. of Samples</u>
Waste Pits	Hazleton	TCL Volatiles	6	1	1	8
	Hazleton	TCL Semi-Volatiles	6	1	1	8
	Hazleton	TCL PCB/Pesticides	6	1	1	8
	Warzyn	TCL Metals	6	1	0	7
	Warzyn	Cyanide	6	1	0	7
Natural Soils -Waste Pit	Hazleton	TCL Volatiles	6	1	0	7
	Hazleton	TCL Semi-Volatiles	6	1	0	7
	Hazleton	TCL PCB/Pesticides	6	1	0	7
	Warzyn	TCL metals	6	1	0	7
	Warzyn	Cyanide	6	1	0	7
Waste Borings	Warzyn	Volatile Residue	6	1	0	7
	Hazleton	TCL Volatiles	8	1	0	9
	Hazleton	TCL Semi-Volatiles	8	1	0	9
	Hazleton	TCL PCB/Pesticides	8	1	0	9
	Warzyn	TCL Metals	8	1	0	9
Natural Soils -Waste Borings	Warzyn	Cyanide	8	1	0	9
	Hazleton	TCL Volatiles	8	1	1	10
	Hazleton	TCL Semi-Volatiles	8	1	1	10
	Hazleton	TCL PCB/Pesticides	8	1	1	10
	Warzyn	TCL Metals	8	1	0	9
Soil Areas	Warzyn	Cyanide	8	1	0	9
	Warzyn	Volatile Residue	8	1	0	9
	Hazleton	TCL Volatiles	8	1	1	10
	Hazleton	TCL Semi-Volatiles	8	1	1	10
	Hazleton	TCL PCB/Pesticides	8	1	1	10
Soil Borings	Warzyn	TCL Metals	8	1	0	9
	Warzyn	Cyanide	8	1	0	9
	Hazleton	TCL Volatiles	12	2	0	14
	Hazleton	TCL Semi-Volatiles	12	2	0	14
	Hazleton	TCL PCB/Pesticides	12	2	0	14
	Warzyn	TCL metals	12	2	0	14
	Warzyn	Cyanide	12	2	0	14

Notes

- 1 Samples will be considered low or medium concentration.
- 2 See Appendix B for TCL Analyte lists - also up to 30 tentatively identified compounds.
- 3 Sample numbers do not reflect the additional volumes required for matrix spike/matrix spike duplicate analysis.
- 4 Field and trip blanks are not required for waste samples.
- 5 Qualitative screening with HNU or OVA will be done for investigative and duplicate samples only.

TABLE 4
SUMMARY OF PHASE I SOURCE CHARACTERIZATION
SAMPLING AND ANALYSIS PROGRAM

<u>Sample Matrix</u> ¹	<u>Laboratory</u>	<u>Laboratory Parameters</u> ²	<u>No. of Investigative Samples</u>	<u>No. of Field Duplicates</u>	<u>No. of Matrix Spike/³ Matrix Spike Duplicates</u>	<u>Total No. of Samples</u>
Waste Pits	Hazleton	TCL Volatiles	6		1	1
	Hazleton	TCL Semi-Volatiles	6		1	1
	Hazleton	TCL PCB/Pesticides	6		1	1
	Warzyn	TCL Metals	6		1	0
	Warzyn	Cyanide	6		1	0
Natural Soils -Waste Pit	Hazleton	TCL Volatiles	6		1	0
	Hazleton	TCL Semi-Volatiles	6		1	0
	Hazleton	TCL PCB/Pesticides	6		1	0
	Warzyn	TCL metals	6		1	0
	Warzyn	Cyanide	6		1	0
Waste Borings	Warzyn	Volatile Residue	6		1	0
	Hazleton	TCL Volatiles	8		1	0
	Hazleton	TCL Semi-Volatiles	8		1	0
	Hazleton	TCL PCB/Pesticides	8		1	0
	Warzyn	TCL Metals	8		1	0
Natural Soils -Waste Borings	Warzyn	Cyanide	8		1	0
	Hazleton	TCL Volatiles	8		1	1
	Hazleton	TCL Semi-Volatiles	8		1	1
	Hazleton	TCL PCB/Pesticides	8		1	1
	Warzyn	TCL Metals	8		1	0
Soil Areas	Warzyn	Cyanide	8		1	0
	Warzyn	Volatile Residue	8		1	0
	Hazleton	TCL Volatiles	8		1	1
	Hazleton	TCL Semi-Volatiles	8		1	1
	Hazleton	TCL PCB/Pesticides	8		1	1
Soil Borings	Warzyn	TCL Metals	8		1	0
	Warzyn	Cyanide	8		1	0
	Hazleton	TCL Volatiles	12		2	0
	Hazleton	TCL Semi-Volatiles	12		2	0
	Hazleton	TCL PCB/Pesticides	12		2	0
	Warzyn	TCL metals	12		2	0
	Warzyn	Cyanide	12		2	0

Notes

- 1 Samples will be considered low or medium concentration.
- 2 See Appendix B for TCL Analyte lists - also up to 30 tentatively identified compounds.
- 3 Sample numbers do not reflect the additional volumes required for matrix spike/matrix spike duplicate analysis.
- 4 Field and trip blanks are not required for soil/waste samples.
- 5 Qualitative screening with HNU or OVA will be done for investigative and duplicate samples only.

TABLE 5
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

<u>Sample⁽¹⁾ Matrix</u>	<u>Laboratory</u>	<u>Laboratory Parameters^(2,5)</u>	<u>Study⁽³⁾ Phase</u>	<u>No. of Investigative Samples</u>	<u>No. of Field Duplicates</u>	<u>No. of Field Blanks</u>	<u>Matrix Spike/⁽⁴⁾ Matrix Spike Duplicate</u>	<u>Total No. of Samples</u>
Groundwater	Hazleton	TCL Volatiles	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Hazleton	TCL Semi-Volatiles	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Hazleton	TCL PCB/Pesticides	1	6	1	1	1	9
			2A	18	2	2	2	24
			2B	*				*
	Warzyn	TCL Metals (Dissolved)	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	TCL Metals (Total), TSS	1	2	1	1	0	4
			2A	5	1	1	0	7
			2B	*				*
	Warzyn	Cyanide (Filtered)	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Chloride, Alkalinity, Sulfate	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Ammonia, Nitrate-Nitrite, TOC, COD	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
	Warzyn	Total Dissolved Solids	1	6	1	1	0	8
			2A	18	2	2	0	22
			2B	*				*
Surface Water	Hazleton	TCL Volatiles	1	11	2	2	2	17
	Hazleton	TCL Semi-Volatiles	1	11	2	2	2	17
	Hazleton	TCL PCB/Pesticides	1	11	2	2	2	17
	Warzyn	TCL Metals (Total)	1	11	2	2	0	15
	Warzyn	Cyanide (Unfiltered)	1	11	2	2	0	15
	Warzyn	Chloride, Alkalinity, Sulfate	1	11	2	2	0	15
	Warzyn	Ammonia, Nitrate-Nitrite, COD	1	11	2	2	0	15
	Warzyn							
Sediment	Hazleton	TCL Volatiles	1	11	2	2	1	16
	Hazleton	TCL Semi-Volatiles	1	11	2	2	1	16

TABLE 5 (Continued)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Sample ⁽¹⁾ Matrix	Laboratory	Laboratory Parameters ^(2,5)	Study ⁽³⁾ Phase	No. of Investigative Samples	No. of Field Duplicates	No. of Field Blanks	Matrix Spike/ ⁽⁴⁾ Matrix Spike Duplicate	Total No. of Samples
Private Wells (Low Detection Limits)	Hazleton	TCL PCB/Pesticides	1	11	2	2	0	15
	Warzyn	TCL Metals	1	11	2	2	0	15
	Warzyn	Cyanide	1	11	2	2	0	15
	Hazleton	TCL Volatiles	2	10	1	1	1	13
	Hazleton	TCL Semi-Volatiles	2	10	1	1	1	13
	Hazleton	TCL PCB/Pesticides	2	10	1	1	1	13
	Warzyn	TCL Metals (Total)	2	10	1	1	0	12
	Warzyn	Cyanide (Unfiltered)	2	10	1	1	0	12
	Warzyn	Chloride, Alkalinity, Sulfate,	2	10	1	1	0	12
	Warzyn	Ammonia, Nitrate-Nitrite, COD	2	10	1	1	0	12
Leachate Wells	Hazleton	TCL Volatiles	1	4	1	1	1	7
	Hazleton	TCL Semi-Volatiles	1	4	1	1	1	7
	Hazleton	TCL PCB/Pesticides	1	4	1	1	1	7
	Warzyn	TCL Metals (Total)	1	4	1	1	0	6
	Warzyn	Cyanide (Unfiltered)	1	4	1	1	0	6
	Warzyn	Chloride, Alkalinity, Sulfate	1	4	1	1	0	6
	Warzyn	Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	1	0	6
	Warzyn	TDS, TSS	1	4	1	1	0	6
	Hazleton	TCL Volatiles	1	4	1	1	1	7
	Hazleton	TCL Semi-Volatiles	1	4	1	1	1	7
ACS Effluent	Hazleton	TCL PCB/Pesticides	1	4	1	1	1	7
	Warzyn	TCL Metals (Total)	1	4	1	1	0	6
	Warzyn	Cyanide (Unfiltered)	1	4	1	1	0	6
	Warzyn	Chloride, Alkalinity, Sulfate	1	4	1	1	0	6
	Warzyn	Ammonia, Nitrate-Nitrite, COD, TOC	1	4	1	1	0	6
	Warzyn	TSS, TDS	1	4	1	1	0	6
	Warzyn	Atterberg limits	1	18	0	0	0	18
	Warzyn	Particle Size	1	18	0	0	0	18
	Warzyn	Coefficient of Permeability	1	18	0	0	0	18
	Warzyn	Cation Exchange Capacity	1	18	0	0	0	18
Geotechnical Samples-Wells	Warzyn	Moisture Content	1	18	0	0	0	18

TABLE 5 (Continued)
SUMMARY OF SITE CHARACTERIZATION SAMPLING AND ANALYSIS PROGRAM

Notes

- 1 Samples will be considered low or medium concentration.
- 2 See Appendix B for TCL analyte lists, also up to 30 tentatively identified compounds.
- 3 The star (*) indicates that the number of samples and specific parameters will be determined from Phase 1 and 2A results. Preliminary assessment indicates that up to 9 wells will be sampled for the complete TCL, and the remaining number will be sampled for a reduced parameter list. Also note that Phase 2A sample number is given as the expected maximum.
- 4 Sample numbers do not reflect the additional volume of samples required for matrix spikes and matrix spike duplicate analysis.
- 5 Temperature, pH and specific conductance measurements will be taken in the field for aqueous samples. Qualitative screening with the HNu or OVA will be performed on solid samples.

TABLE 6
ORGANIC PARAMETERS
CLP TARGET COMPOUND LIST AND
CONTRACT REQUIRED DETECTION LIMITS (CRDL)*

	<u>Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
			<u>Water</u> <u>ug/l</u>	<u>Low Soil/ Sediment(a)</u> <u>ug/kg</u>
1.	Chloromethane	74-87-3	10	10
2.	Bromomethane	74-83-9	10	10
3.	Vinyl Chloride	75-01-4	10	10
4.	Chloroethane	75-00-3	10	10
5.	Methylene Chloride	75-09-2	5	5
6.	Acetone	67-64-1	10	10
7.	Carbon Disulfide	75-15-0	5	5
8.	1,1-Dichloroethene	75-35-4	5	5
9.	1,1-Dichloroethane	75-35-3	5	5
10.	1,2-Dichloroethene (Total)	540-59-0	5	5
11.	Chloroform	67-66-3	5	5
12.	1,2-Dichloroethane	107-06-2	5	5
13.	2-Butanone	78-93-3	10	10
14.	1,1,1-Trichloroethane	71-55-6	5	5
15.	Carbon Tetrachloride	56-23-5	5	5
16.	Vinyl Acetate	108-05-4	10	10
17.	Bromodichloromethane	75-27-4	5	5
18.	1,2-Dichloropropane	78-87-5	5	5
19.	cis-1,3-Dichloropropene	10061-01-5	5	5
20.	Trichloroethene	79-01-6	5	5
21.	Dibromochloromethane	124-48-1	5	5
22.	1,1,2-Trichloroethane	79-00-5	5	5
23.	Benzene	71-43-2	5	5
24.	trans-1,3-Dichloropropene	10061-02-6	5	5
25.	Bromoform	75-25-2	5	5
26.	4-Methyl-2-pentanone	108-10-1	10	10
27.	2-Hexanone	591-78-6	10	10
28.	Tetrachloroethene	127-18-4	5	5
29.	Toluene	108-88-3	5	5
30.	1,1,2,2-Tetrachloroethane	79-34-5	5	5
31.	Chlorobenzene	108-90-7	5	5
32.	Ethyl Benzene	100-41-4	5	5
33.	Styrene	100-42-5	5	5
34.	Total Xylenes	1330-20-7	5	5

	<u>Semi-Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
			<u>Water</u> <u>ug/l</u>	<u>Low Soil</u> <u>Sediment(a)</u> <u>ug/kg</u>
35.	Phenol	108-95-2	10	330
36.	bis(2-Chloroethyl)ether	111-44-4	10	330
37.	2-Chlorophenol	95-57-8	10	330
38.	1,3-Dichlorobenzene	541-73-1	10	330
39.	1,4-Dichlorobenzene	106-46-7	10	330
40.	Benzyl Alcohol	100-51-6	10	330
41.	1,2-Dichlorobenzene	95-50-1	10	330
42.	2-Methylphenol	95-48-7	10	330
43.	bis(2-Chloroisopropyl)ether	108-60-1	10	330
44.	4-Methylphenol	106-44-5	10	330
45.	N-Nitroso-Dinpropylamine	621-64-7	10	330
46.	Hexachloroethane	67-72-1	10	330
47.	Nitrobenzene	98-95-3	10	330
48.	Isophorone	78-59-1	10	330
49.	2-Nitrophenol	88-75-5	10	330
50.	2,4-Dimethylphenol	105-67-9	10	330
51.	Benzoic Acid	65-85-0	50	1600
52.	bis(2-Chloroethoxy)methane	111-91-1	10	330
53.	2,4-Dichlorophenol	120-83-2	10	330
54.	1,2,4-Trichlorobenzene	120-82-1	10	330
55.	Naphthalene	91-20-3	10	330
56.	4-Chloroaniline	106-47-8	10	330
57.	Hexachlorobutadiene	87-68-3	10	330
58.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59.	2-Methylnaphthalene	91-57-6	10	330
60.	Hexachlorocyclopentadiene	77-47-4	10	330
61.	2,4,6-Trichlorophenol	88-06-2	10	330
62.	2,4,5-Trichlorophenol	95-95-4	50	1600
63.	2-Chloronaphthalene	91-58-7	10	330
64.	2-Nitroaniline	88-74-4	50	1600
65.	Dimethyl Phthalate	131-11-3	10	330
66.	Acenaphthylene	208-96-8	10	330
67.	2,6-Dinitrotoluene	606-20-2	10	330
68.	3-Nitroaniline	99-09-2	50	1600
69.	Acenaphthene	83-32-9	10	330
70.	2,4-Dinitrophenol	51-28-5	50	1600
71.	4-Nitrophenol	100-02-7	50	1600
72.	Dibenzofuran	132-64-9	10	330
73.	2,4-Dinitrotoluene	121-14-2	10	330
74.	Diethylphthalate	84-66-2	10	330
75.	4-Chlorophenyl phenyl ether	7005-72-3	10	330
76.	Fluorene	86-73-7	10	330

			<u>Quantitation Limits**</u>	
			<u>Water</u>	<u>Low Soil</u>
			<u>ug/l</u>	<u>Sediment (c)</u>
				<u>ug/kg</u>
		<u>CAS Number</u>		
77.	4-Nitroaniline	100-01-6	50	1600
78.	4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79.	N-nitrosodiphenylamine	86-30-6	10	330
80.	4-Bromophenyl phenyl ether	101-55-3	10	330
81.	Hexachlorobenzene	118-74-1	10	330
82.	Pentachlorophenol	87-86-5	50	1600
83.	Phenanthrene	85-01-8	10	330
84.	Anthracene	120-12-7	10	330
85.	Di-n-butylphthalate	84-74-2	10	330
86.	Fluoranthene	206-44-0	10	330
87.	Pyrene	129-00-0	10	330
88.	Butylbenzylphthalate	85-68-7	10	330
89.	3,3'-Dichlorobenzidine	91-94-1	10	330
90.	Benzo(a)anthracene	56-55-3	20	660
91.	Chrysene	218-01-9	10	330
92.	bis(2-ethylhexyl)phthalate	117-81-7	10	330
93.	Di-n-octylphthalate	117-84-0	10	330
94.	Benzo(b)fluoranthene	205-99-2	10	330
95.	Benzo(k)fluoranthene	207-08-9	10	330
96.	Benzo(a)pyrene	50-32-8	10	330
97.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98.	Dibenz(a,h)anthracene	53-70-3	19	330
99.	Benzo(g,h,i)perylene	191-24-2	10	330

Pesticides/PCBs

100.	alpha-BHC	319-84-6	0.05	8.0
101.	beta-BHC	319-85-7	0.05	8.0
102.	delta-BHC	319-86-8	0.05	8.0
103.	gamma-BHC (Lindane)	58-89-9	0.05	8.0
104.	Heptachlor	76-44-8	0.05	8.0
105.	Aldrin	309-00-2	0.05	8.0
106.	Heptachlor epoxide	1024-57-3	0.05	8.0
107.	Endosulfan I	959-98-8	0.05	8.0
108.	Dieldrin	60-57-1	0.10	16.0
109.	4,4'-DDE	75-55-9	0.10	16.0
110.	Endrin	72-20-8	0.10	16.0
111.	Endosulfan II	33213-65-9	0.10	16.0
112.	4,4-DDD	72-54-8	0.10	16.0
113.	Endosulfan Sulfate	1031-07-8	0.10	16.0
114.	4,4'-DDT	50-29-3	0.10	16.0

		<u>Quantitation Limits**</u>	
		<u>Water</u>	<u>Low Soil</u>
		<u>ug/l</u>	<u>Sediment(c)</u>
	<u>CAS Number</u>		<u>ug/kg</u>
115.	Endrin Ketone	53494-70-5	0.10
116.	Methoxychlor	72-43-5	0.5
117.	alpha-Chlorodane	5103-71-9	0.5
118.	gamma-Chlordane	5103-74-2	0.5
119.	Toxaphene	8001-35-2	1.0
120.	AROCLOR-1016	12674-11-2	0.5
121.	AROCLOR-1221	11104-28-2	0.5
122.	AROCLOR-1232	11141-16-5	0.5
123.	AROCLOR-1242	53469-21-9	0.5
124.	AROCLOR-1248	12672-29-6	0.5
125.	AROCLOR-1254	11097-69-1	1.0
126.	AROCLOR-1260	11096-82-5	1.0

NOTES

- a. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.
 - b. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Semivolatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.
 - c. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL compounds are 15 times the individual low Soil/Sediment CRQL.
- * Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable. For quantification limits for water samples from private wells, see SOP.
- ** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher. Quantification limits for water samples from private wells are lower than tabled values, see SOP for details.

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For Lead:

Method in use - ICP

Instrument Detection Limit (IDL) - 40

Sample concentration - 220

Contract Required Detection Limit (CRCL) - 5

- (2) The value of 200 may be reported even though instrument detection limits obtained in pure water that may be met during the procedure in Exhibit E of SOW 7/87. The detection limits for samples may be considerably higher depending on the sample matrix.

**TABLE 7
TARGET COMPOUND LIST
INORGANIC PARAMETERS**

**ELEMENTS DETERMINED BY
INDUCTIVELY COUPLED PLASMA EMISSION
OR ATOMIC ABSORPTION SPECTROSCOPY**

<u>Metal</u>	<u>Required Detection Level(1) Water ug/l</u>
Aluminum	200
Antimony	5
Arsenic	2
Barium	200
Beryllium	0.2
Cadmium	0.2
Calcium	50
Chromium	0.2
Cobalt	50
Copper	20
Iron	50
Lead	3
Magnesium	50
Manganese	15
Mercury	0.2
Nickel	40
Potassium	100
Selenium	2
Silver	10
Sodium	1000
Thallium	5
Vanadium	2
Zinc	10
<u>Other</u>	
Cyanide	10

NOTES

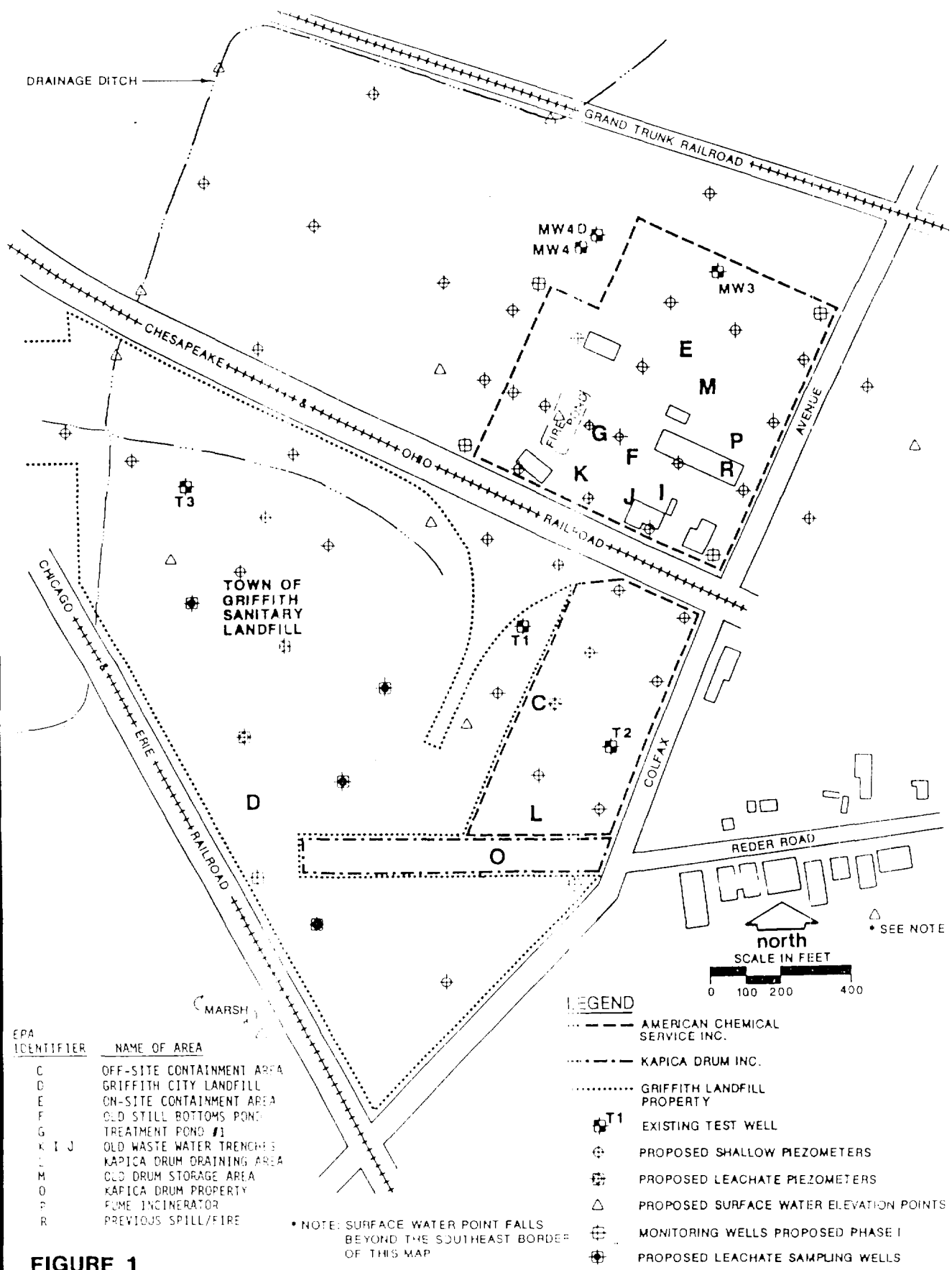
- (1) Subject to the restrictions specified in the first part of Part G, Section IV of Exhibit F (Alternative Methods - Catastrophic Failure) of SOW-7/87. Any analytical method specified in SOW 7/87, Exhibit F may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstance:

TABLE 8
NON-TCL
ADDITIONAL WATER QUALITY PARAMETERS

<u>Parameter</u>	<u>Detection Limits (mg/l)</u>
Total Organic Carbon.....	1.0
Total Suspended Solids.....	1
Total Dissolved Solids.....	10
Chemical Oxygen Demand.....	2.0
Alkalinity (as CaCO_3).....	5.0
Ammonia.....	0.10
Nitrate-Nitrite.....	0.02
Chloride.....	1.0
Sulfate.....	5.0

TABLE 9
INORGANIC PARAMETERS
NON-TCL LOW DETECTION
LIMITS

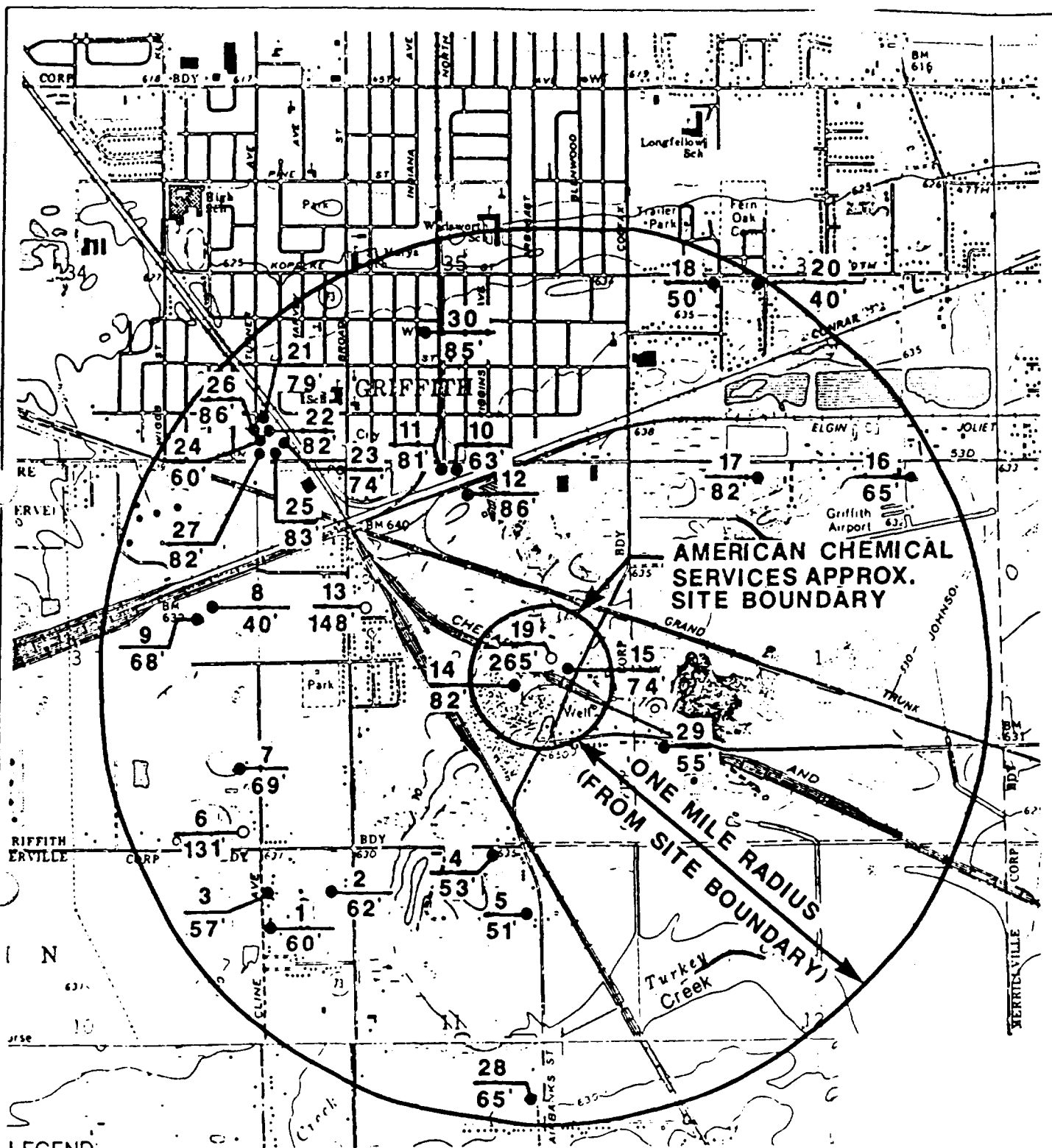
<u>Metal</u>	Required Detection Level Water ug/l
Aluminum	200
Antimony	5
Arsenic	2
Barium	5
Beryllium	0.2
Cadmium	0.2
Calcium	50
Chromium	0.2
Cobalt	50
Copper	20
Iron	50
Lead	3
Magnesium	50
Manganese	15
Mercury	0.2
Nickel	40
Potassium	100
Selenium	2
Silver	1
Sodium	1000
Thallium	5
Vanadium	2
Zinc	10
<u>Other</u>	
Cyanide	10



EPA IDENTIFIER	NAME OF AREA
C	OFF-SITE CONTAINMENT AREA
D	GRIFFITH CITY LANDFILL
E	ON-SITE CONTAINMENT AREA
F	OLD STILL BOTTOMS POND
G	TREATMENT POND #1
H, I, J	OLD WASTE WATER TRENCHES
L	KAPICA DRUM DRAINING AREA
M	OLD DRUM STORAGE AREA
O	KAPICA DRUM PROPERTY
P	FUME INCINERATOR
R	PREVIOUS SPILL/FIRE

FIGURE 1

	60251-82	HYDROGEOLOGIC STUDY WATER LEVEL CONTROL POINTS	WARZYN	Designed By	Drawn By <i>SE</i>	Checked By <i>2/1/88</i>
		REMEDIAL INVESTIGATION/		Approved By <i>FSU</i>		Date <i>7/2/88</i>
		FEASIBILITY STUDY		Scale	AS SHOWN	
		AMERICAN CHEMICAL SERVICES SITE				
		GRIFFITH, INDIANA				



LEGEND

- 1 - WELL REFERENCE NUMBER
- 60 - DEPTH OF WELL (FEET)

- WELL SCREENED IN UNCONSOLIDATED AQUIFER
- WELL SCREENED IN ROCK AQUIFER

NOTE

1. BASE MAP DEVELOPED FROM THE HIGHLAND, INDIANA AND THE ST. JOHN, INDIANA 7 1/2 MINUTE USGS QUADRANGLE MAPS. DATED 1968 AND 1962 RESPECTIVELY PHOTOREVISED 1980.
2. WELL REFERENCE NUMBERS REFER TO ATEC REPORT, JANUARY 1985.

north
SCALE: 1"=2000'

FIGURE 2

WARZYN

REMEDIAL INVESTIGATION/FEASIBILITY STUDY
WATER WELL LOCATIONS
AMERICAN CHEMICAL SERVICES SITE
GRIFFITH, INDIANA

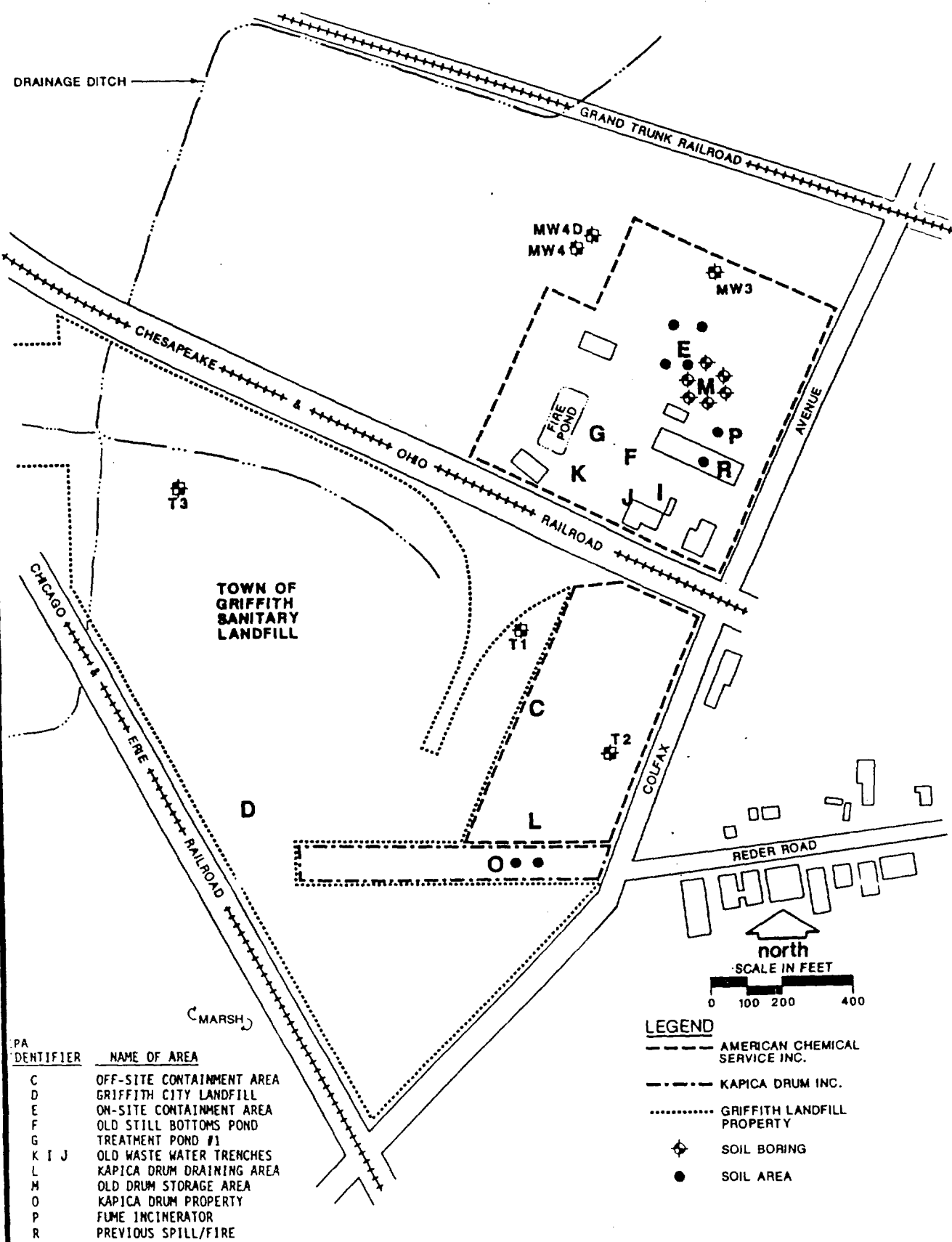


FIGURE 3

<p>98-151-86</p>	SOIL BORING & SOIL AREA LOCATIONS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AMERICAN CHEMICAL SERVICES SITE GRIFFITH, INDIANA	WARZYN <small>ENGINEERING & SURVEYING, INC.</small> <small>INDIANAPOLIS • CHICAGO • CHICAGO • CHICAGO</small>	Designed By _____ Drawn By <i>SB</i> Checked By <i>MB</i> Approved By <i>POV</i> Date <i>9/25/88</i> Scale <i>AS SHOWN</i>
	By 1047 - Warzyn Engineering Inc. - All Rights Reserved		

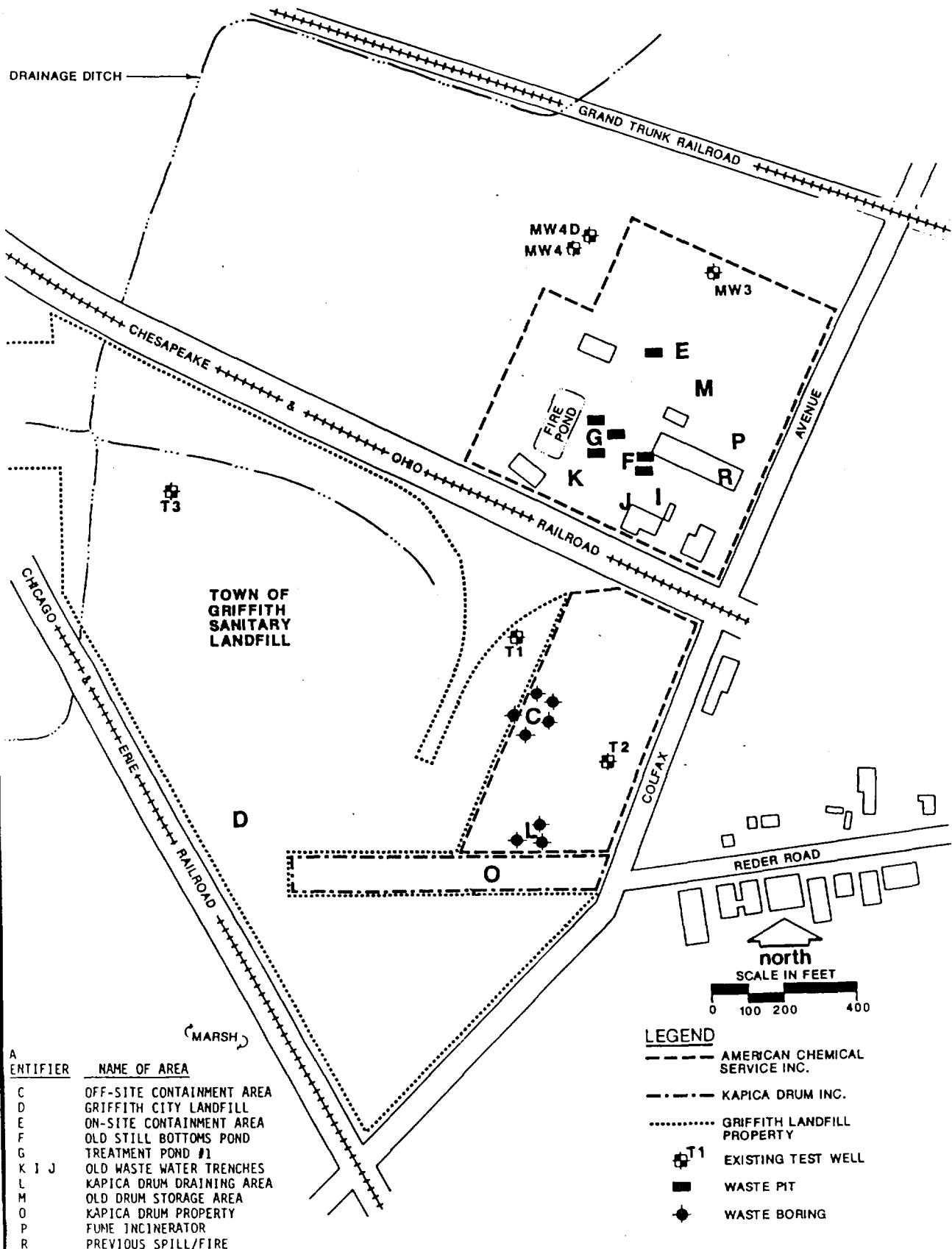


FIGURE 4

 60251-85	WASTE PIT & WASTE BORING LOCATIONS REMEDIAL INVESTIGATION/ FEASIBILITY STUDY AMERICAN CHEMICAL SERVICES SITE GRIFFITH, INDIANA	WARZYN <small>WARZYN ENGINEERING INC.</small> <small>1000 N. WABASH AVE.</small> <small>CHICAGO, ILL. 60642</small>	Drawn by <i>SP</i> Approved by <i>RSV</i> Date <i>9/28/27</i> Scale <i>AS SHOWN</i>
	Created by <i>mya</i>		
	Reviewed by		
	Checked by		

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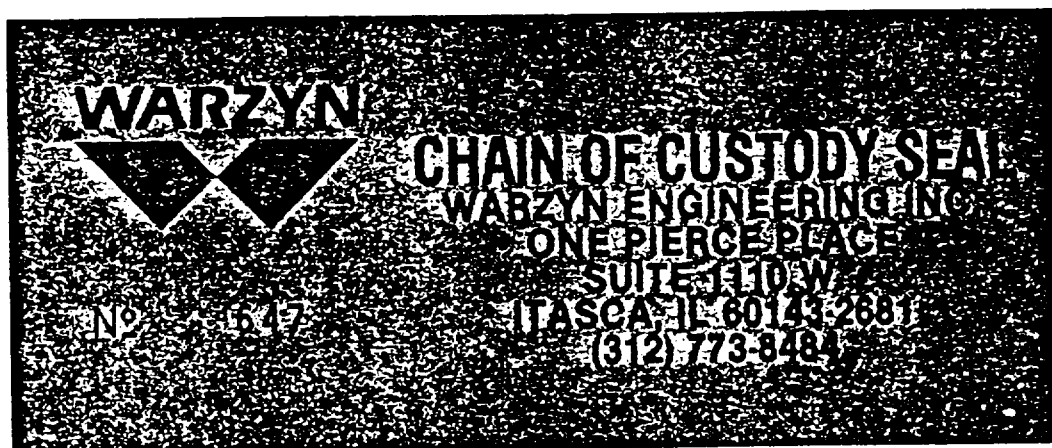



Figure 6. Chain-of-Custody Seal

Figure 7. Sample label

ANALYTICAL SERVICES	
WARZYN ENGINEERING INC	
	
One Science Court University Research Park P.O. Box 5385 Madison, WI 53705 (608) 273-0440	
Project # _____	Lab # _____
Sample Name _____	
Date Collected _____	By _____
Parameters _____	
Preservatives _____	

SAMPLE IDENTIFICATION RECORD

CASE/JOB NUMBER	MATRIX	SAMPLE NUMBER	LAB	LAB NUMBER	CHAIN OF CUSTODY	DATE SAMPLED	DATE SHIPPED	AIRBILL NUMBER

Figure 8. Sample Identification Record.

APPENDIX C

ANALYTE LISTS

**ORGANIC PARAMETERS
CLP TARGET COMPOUND LIST AND
CONTRACT REQUIRED DETECTION LIMITS (CRDL)***

	<u>Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
			<u>Water</u> <u>ug/l</u>	<u>Low Soil/ Sediment (a)</u> <u>ug/kg</u>
1.	Chloromethane	74-87-3	10	10
2.	Bromomethane	74-83-9	10	10
3.	Vinyl Chloride	75-01-4	10	10
4.	Chloroethane	75-00-3	10	10
5.	Methylene Chloride	75-09-2	5	5
6.	Acetone	67-64-1	10	10
7.	Carbon Disulfide	75-15-0	5	5
8.	1,1-Dichloroethene	75-35-4	5	5
9.	1,1-Dichloroethane	75-35-3	5	5
10.	1,2-Dichloroethene (Total)	540-59-0	5	5
11.	Chloroform	67-66-3	5	5
12.	1,2-Dichloroethane	107-06-2	5	5
13.	2-Butanone	78-93-3	10	10
14.	1,1,1-Trichloroethane	71-55-6	5	5
15.	Carbon Tetrachloride	56-23-5	5	5
16.	Vinyl Acetate	108-05-4	10	10
17.	Bromodichloromethane	75-27-4	5	5
18.	1,2-Dichloropropane	78-87-5	5	5
19.	cis-1,3-Dichloropropene	10061-01-5	5	5
20.	Trichloroethene	79-01-6	5	5
21.	Dibromochloromethane	124-48-1	5	5
22.	1,1,2-Trichloroethane	79-00-5	5	5
23.	Benzene	71-43-2	5	5
24.	trans-1,3-Dichloropropene	10061-02-6	5	5
25.	Bromoform	75-25-2	5	5
26.	4-Methyl-2-pentanone	108-10-1	10	10
27.	2-Hexanone	591-78-6	10	10
28.	Tetrachloroethene	127-18-4	5	5
29.	Toluene	108-88-3	5	5
30.	1,1,2,2-Tetrachloroethane	79-34-5	5	5
31.	Chlorobenzene	108-90-7	5	5
32.	Ethyl Benzene	100-41-4	5	5
33.	Styrene	100-42-5	5	5
34.	Total Xylenes	1330-20-7	5	5

	<u>Semi-Volatiles</u>	<u>CAS Number</u>	<u>Quantitation Limits**</u>	
			<u>Water</u> <u>ug/l</u>	<u>Low Soil</u> <u>Sediment(a)</u> <u>ug/kg</u>
35.	Phenol	108-95-2	10	330
36.	bis(2-Chloroethyl)ether	111-44-4	10	330
37.	2-Chlorophenol	95-57-8	10	330
38.	1,3-Dichlorobenzene	541-73-1	10	330
39.	1,4-Dichlorobenzene	106-46-7	10	330
40.	Benzyl Alcohol	100-51-6	10	330
41.	1,2-Dichlorobenzene	95-50-1	10	330
42.	2-Methylphenol	95-48-7	10	330
43.	bis(2-Chloroisopropyl)ether	108-60-1	10	330
44.	4-Methylphenol	106-44-5	10	330
45.	N-Nitroso-Dinpropylamine	621-64-7	10	330
46.	Hexachloroethane	67-72-1	10	330
47.	Nitrobenzene	98-95-3	10	330
48.	Isophorone	78-59-1	10	330
49.	2-Nitrophenol	88-75-5	10	330
50.	2,4-Dimethylphenol	105-67-9	10	330
51.	Benzoic Acid	65-85-0	50	1600
52.	bis(2-Chloroethoxy)methane	111-91-1	10	330
53.	2,4-Dichlorophenol	120-83-2	10	330
54.	1,2,4-Trichlorobenzene	120-82-1	10	330
55.	Naphthalene	91-20-3	10	330
56.	4-Chloroaniline	106-47-8	10	330
57.	Hexachlorobutadiene	87-68-3	10	330
58.	4-Chloro-3-methylphenol (para-chloro-meta-cresol)	59-50-7	10	330
59.	2-Methylnaphthalene	91-57-6	10	330
60.	Hexachlorocyclopentadiene	77-47-4	10	330
61.	2,4,6-Trichlorophenol	88-06-2	10	330
62.	2,4,5-Trichlorophenol	95-95-4	50	1600
63.	2-Chloronaphthalene	91-58-7	10	330
64.	2-Nitroaniline	88-74-4	50	1600
65.	Dimethyl Phthalate	131-11-3	10	330
66.	Acenaphthylene	208-96-8	10	330
67.	2,6-Dinitrotoluene	606-20-2	10	330
68.	3-Nitroaniline	99-09-2	50	1600
69.	Acenaphthene	83-32-9	10	330
70.	2,4-Dinitrophenol	51-28-5	50	1600
71.	4-Nitrophenol	100-02-7	50	1600
72.	Dibenzofuran	132-64-9	10	330
73.	2,4-Dinitrotoluene	121-14-2	10	330
74.	Diethylphthalate	84-66-2	10	330
75.	4-Chlorophenyl phenyl ether	7005-72-3	10	330
76.	Fluorene	86-73-7	10	330

		<u>Quantitation Limits**</u>		
		<u>Water</u>	<u>Low Soil</u>	
		<u>ug/l</u>	<u>Sediment(c)</u>	
			<u>ug/kg</u>	
	<u>CAS Number</u>			
77.	4-Nitroaniline	100-01-6	50	1600
78.	4,6-Dinitro-2-methylphenol	534-52-1	50	1600
79.	N-nitrosodiphenylamine	86-30-6	10	330
80.	4-Bromophenyl phenyl ether	101-55-3	10	330
81.	Hexachlorobenzene	118-74-1	10	330
82.	Pentachlorophenol	87-86-5	50	1600
83.	Phenanthrene	85-01-8	10	330
84.	Anthracene	120-12-7	10	330
85.	Di-n-butylphthalate	84-74-2	10	330
86.	Fluoranthene	206-44-0	10	330
87.	Pyrene	129-00-0	10	330
88.	Butylbenzylphthalate	85-68-7	10	330
89.	3,3'-Dichlorobenzidine	91-94-1	10	330
90.	Benzo(a)anthracene	56-55-3	20	660
91.	Chrysene	218-01-9	10	330
92.	bis(2-ethylhexyl)phthalate	117-81-7	10	330
93.	Di-n-octylphthalate	117-84-0	10	330
94.	Benzo(b)fluoranthene	205-99-2	10	330
95.	Benzo(k)fluoranthene	207-08-9	10	330
96.	Benzo(a)pyrene	50-32-8	10	330
97.	Indeno(1,2,3-cd)pyrene	193-39-5	10	330
98.	Dibenz(a,h)anthracene	53-70-3	19	330
99.	Benzo(g,h,i)perylene	191-24-2	10	330

Pesticides/PCBs

100.	alpha-BHC	319-84-6	0.05	8.0
101.	beta-BHC	319-85-7	0.05	8.0
102.	delta-BHC	319-86-8	0.05	8.0
103.	gamma-BHC (Lindane)	58-89-9	0.05	8.0
104.	Heptachlor	76-44-8	0.05	8.0
105.	Aldrin	309-00-2	0.05	8.0
106.	Heptachlor epoxide	1024-57-3	0.05	8.0
107.	Endosulfan I	959-98-8	0.05	8.0
108.	Dieldrin	60-57-1	0.10	16.0
109.	4,4'-DDE	75-55-9	0.10	16.0
110.	Endrin	72-20-8	0.10	16.0
111.	Endosulfan II	33213-65-9	0.10	16.0
112.	4,4-DDD	72-54-8	0.10	16.0
113.	Endosulfan Sulfate	1031-07-8	0.10	16.0
114.	4,4'-DDT	50-29-3	0.10	16.0

		<u>Quantitation Limits**</u>	
		<u>Water</u>	<u>Low Soil</u>
		<u>ug/l</u>	<u>Sediment(c)</u>
	<u>CAS Number</u>		<u>ug/kg</u>
115.	Endrin Ketone	53494-70-5	0.10
116.	Methoxychlor	72-43-5	0.5
117.	alpha-Chlorodane	5103-71-9	0.5
118.	gamma-Clordane	5103-74-2	0.5
119.	Toxaphene	8001-35-2	1.0
120.	AROCLOR-1016	12674-11-2	0.5
121.	AROCLOR-1221	11104-28-2	0.5
122.	AROCLOR-1232	11141-16-5	0.5
123.	AROCLOR-1242	53469-21-9	0.5
124.	AROCLOR-1248	12672-29-6	0.5
125.	AROCLOR-1254	11097-69-1	1.0
126.	AROCLOR-1260	11096-82-5	1.0

NOTES

- a. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Volatile TCL Compounds are 125 times the individual Low Soil/Sediment CRQL.
- b. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Semivolatile TCL Compounds are 60 times the individual Low Soil/Sediment CRQL.
- c. Medium Soil/Sediment Contract Required Quantitation Limits (CRQL) for Pesticide/PCB TCL compounds are 15 times the individual low Soil/Sediment CRQL.

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable. For quantification limits for water samples from private wells, see SOP.

** Quantitation limits listed for soil/sediment are based on wet weight. The quantitation limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher. Quantification limits for water samples from private wells are lower than tabled values, see SOP for details.

**TARGET COMPOUND LIST
INORGANIC PARAMETERS**

**ELEMENTS DETERMINED BY
INDUCTIVELY COUPLED PLASMA EMISSION
OR ATOMIC ABSORPTION SPECTROSCOPY**

<u>Metal</u>	Required Detection Level(1)
	<u>Water</u> <u>ug/l</u>
Aluminum	200
Antimony	60
Arsenic	10
Barium	200
Beryllium	5
Cadmium	5
Calcium	5000
Chromium	10
Cobalt	50
Copper	25
Iron	100
Lead	5
Magnesium	5000
Manganese	15
Mercury	0.2
Nickel	40
Potassium	5000
Selenium	5
Silver	10
Sodium	5000
Thallium	10
Vanadium	50
Zinc	20
<u>Other</u>	
Cyanide	10

NOTES

- (1) Subject to the restrictions specified in the first part of Part G, Section IV of Exhibit D (Alternative Methods - Catastrophic Failure) of SOW-7/87. Any analytical method specified in SOW 7/87, Exhibit D may be utilized as long as the documented instrument or method detection limits meet the Contract Required Detection Limit (CRDL) requirements. Higher detection limits may only be used in the following circumstance:

If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the Contract Required Detection Limit. This is illustrated in the example below:

For Lead:

Method in use - ICP

Instrument Detection Limit (IDL) - 40

Sample concentration - 220

Contract Required Detection Limit (CRCL) - 5

- (2) The value of 200 may be reported even though instrument detection limits obtained in pure water that may be met during the procedure in Exhibit E of SOW 7/87. The detection limits for samples may be considerably higher depending on the sample matrix.

**NON-TCL
ADDITIONAL WATER QUALITY PARAMETERS**

<u>Parameter</u>	<u>Detection Limits (mg/l)</u>
Total Organic Carbon.....	1.0
Total Suspended Solids.....	1
Total Dissolved Solids.....	10
Chemical Oxygen Demand.....	2.0
Alkalinity (as CaCO_3).....	5.0
Ammonia.....	0.10
Nitrate-Nitrite.....	0.02
Chloride.....	1.0
Sulfate.....	5.0

DETECTION LIMIT SUMMARY TABLE

	<u>CRDL (MG/L)</u>	<u>GROUNDWATER (MG/L)</u>	<u>PRIVATE WELLS (MG/L)</u>
ALUMINUM	0.20	0.20	0.20
ANTIMONY	0.06	0.005	0.005
ARSENIC	0.01	0.002	0.002
BARIUM	0.20	0.20	0.005
BERYLLIUM	0.005	0.0002	0.0002
CADMIUM	0.005	0.0002	0.0002
CALCIUM	5.0	0.05	0.05
CHROMIUM	0.01	0.0002	0.0002
COBALT	0.05	0.05	0.05
COPPER	0.025	0.02	0.02
IRON	0.10	0.05	0.05
LEAD	0.003	0.003	0.003
MAGNESIUM	5.0	0.05	0.05
MANGANESE	0.015	0.015	0.015
MERCURY	0.0002	0.0002	0.0002
NICKEL	0.04	0.04	0.04
POTASSIUM	5.0	0.10	0.10
SELENIUM	0.005	0.002	0.002
SILVER	0.01	0.01	0.001
SODIUM	5.0	1.0	1.0
THALLIUM	0.01	0.005	0.005
VANADIUM	0.05	0.002	0.002
ZINC	0.02	0.01	0.01

APPENDIX D

**QUALITY ASSURANCE GUIDELINES FOR
GROUNDWATER INVESTIGATIONS**

Quality Assurance Guidelines for Ground-Water Investigations: The Requirements

REFERENCE: van Ee, J. J. and McMillion, L. G., "Quality Assurance Guidelines for Ground-Water Investigations: The Requirements," *Ground-Water Contamination: Field Methods*, ASTM STP 963, A. G. Collins and A. I. Johnson, Eds., American Society for Testing and Materials, Philadelphia, 1988, pp. 27-34.

ABSTRACT: The U.S. Environmental Protection Agency (EPA) is required to assess the quality of data that are collected in its research and monitoring programs, and this requirement is meant to apply to established areas such as air and water pollution monitoring as well as to the emerging use of geophysics in ground-water investigations. The Agency's quality assurance requirements are outlined, and the ability to meet the requirements in ground-water investigations is discussed. Suggestions are offered on how standards and standard methods can be developed, based upon the experiences obtained in the implementation of monitoring programs in air pollution in the 1970's. The concept of reference and equivalent methods is compared in the monitoring of the air quality with the assessment of ground-water quality for the EPA. The applicability of quality assurance to the many and varied steps in a ground-water investigation is discussed with emphasis given to geophysics. The lack of standard procedures and quality assurance guidelines for geophysical investigations of hazardous waste sites poses serious questions to the acceptance of emerging disciplines for ground-water quality studies.

KEY WORDS: quality assurance, ground water, geophysics, hazardous waste, site investigations, standards, standard methods, reference and equivalent methods

Although the science of hydrology has been in existence for years, standard procedures for sampling of ground water, especially for organic contaminants, are not well developed. In the past, the quantity and movement of the ground water has been of most concern. Today, with the passage of the Clean Water Act (CWA), the Safe Drinking Water Act (SDWA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), the monitoring and protection of the quality of ground water is of intense concern. Private industry and Federal, state, and local agencies are making a variety of chemical, physical, and bacteriological measurements of ground water, for example, water table level and total dissolved solids (TDS) levels. Whether or not these measurements are providing data that can be intracompared and compared against standards in a scientifically and defensible way is debatable. Data that are inaccurate, imprecise, and not representative of the monitoring zone can lead to conclusions that may be costly and hazardous to the public and private sectors. Poor quality or improperly analyzed data at Superfund or RCRA sites are particularly troublesome because of the potentially large hazards and financial risks that are involved with these hazardous waste sites. With the large amount of data being collected by a great number of organizations and individuals, there are many potential sources of error. Unfortunately, little attention has been paid to determining the extent of those errors. Documented.

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uniform quality assurance practices which are aimed at reducing those errors are not well developed in the ground-water industry at this time.

The Environmental Protection Agency's (EPA) Office of Ground Water Protection has recently drafted a strategy for the Agency to follow in the implementation of the numerous laws that Congress has passed to protect the nation's ground water. The strategy emphasizes the importance of quality assurance in the sampling of ground water. The role of the United States Geological Survey is also recognized by the EPA as being important to the widespread characterization of ground-water resources. Other Federal agencies, such as the Nuclear Regulatory Commission and the Department of Agriculture, are involved in the study of ground water, and the data that they collect are important in providing an understanding of the ground water in the United States. State and local agencies conduct ground-water studies within their regions. Professional organizations, such as the American Society for Testing and Materials (ASTM), the National Water Well Association (NWWA), and the Society of Exploration Geophysicists (SEG), also participate in the study of ground water. Universities, colleges, and research institutes conduct research. Finally, private industry often conducts, or contracts, ground-water studies. The degree of quality assurance exercised by these various organizations varies, and the comparability of the data they collect may be poor, given the lack of industry-wide standards in the monitoring of ground water.

Application of Quality Assurance Guidelines to Ground-Water Investigations

The EPA Quality Assurance (QA) and Monitoring Staff recognized in 1980 the need for quality assurance in the many studies that EPA conducts and finances in its environmental studies. The EPA developed a list of 16 points (Table 1) that should be addressed prior to the conduct of those environmental studies. These points apply to in-house efforts, contracts, cooperative agreements, and interagency agreements. EPA studies involving Federal, state, and local agencies as well as private industry and academia fall under these guidelines (QAMS-001-005/80) [1-3]. Although all of the points may not apply to a particular study, their intent is clear. Quality assurance should be considered prior to the conduct of a study so that sound scientific practices will lead to the

TABLE 1—Required elements (when applicable) for QA (project) plans for monitoring and measurement projects (QAMS-002/80).

Element
1. Title page, with provision for approval signatures
2. Table of contents
3. Project description
4. Project organization and responsibilities
5. QA objectives for measurement data in terms of precision, accuracy, completeness, representativeness, and comparability
6. Sampling procedures
7. Sample custody
8. Calibration procedures, references, and frequency
9. Analytical procedures
10. Data reduction, validation, and reporting
11. Internal QC checks and frequency
12. QA performance audits, system audits, and frequency
13. QA reports to management
14. Preventive maintenance procedures and schedule
15. Specific procedures to be used to routinely assess and document data precision, representativeness, comparability, accuracy, and completeness of specific measurement parameters involved
16. Corrective action

collection of scientifically, and (if needed) legally, sound data. Since the EPA guidelines are written in general terms, there can be problems in applying them to specific projects, particularly when the research or environmental monitoring involves the use of innovative techniques or techniques for which there is little history in the way of established standards, procedures, or quality assurance documentation. The present increased interest and resultant studies of the quality of this nation's ground water come at a time when interest in formal quality assurance programs for ground-water investigations is just developing; thus, the application of the EPA guidelines to ground-water studies may require broad interpretation and innovation to ensure that sound data are collected.

Air Pollution and Ground Water: The Analogy

The present heightened interest in ground-water protection can be likened to the 1970's when air pollution was a major priority of the EPA. The present quality assurance efforts in air pollution monitoring, while not perfect, can be more readily understood because many of the struggles are now history. The lessons learned from the application of quality assurance principles to the then emerging field of air pollution study can be applied to today's problems in ground-water monitoring; however, there are limits to the analogy. Measurements of water are made more difficult by the fact that hydrological and geological investigations are conducted in an anisotropic, nonhomogeneous, relatively isolated media.

The study of air pollution can be broken down into two basic areas: the definition of the source and the measurement of the ambient air quality. Standard procedures and quality assurance guidelines have been developed for the measurement of pollutants from the source, for example, the smokestack, or the tailpipe. Standard procedures and quality assurance guidelines have also been developed for the measurement of the ambient air quality with separate procedures and QA guidelines having been developed for the location of the sampling instrumentation that is used to characterize the air quality in a large region, such as a city, or state. Standards have been developed to protect the public health and welfare from some pollutants and hazardous substances, and monitoring is performed in both the establishment of health standards for a particular pollutant and in measuring compliance with ambient standards that are based upon those health standards. Some of the same basic principles developed for air quality are just now being developed for ground water. The study of air pollution has benefited in the past from a large commitment of resources to QA. In comparison, few resources have been devoted to QA for ground-water monitoring; thus, it will be some time before methods and standards for ground-water investigations become as well defined as they are for air monitoring investigations.

This paper compares an approach EPA used to implement quality assurance guidelines for ambient air monitoring with the proposed development of procedures and criteria for the testing and certification, usage, and siting of instruments for the monitoring of the ground water and soil, for example, outside the fence line of an RCRA or Superfund site. The EPA sanctioned the concept of "reference methods" and "equivalency" for the instrumentation used to make ambient air measurements. Guideline and quality assurance documents were developed, under different regulatory authority, for the location and usage of these instruments in measuring the quality of the ambient air. Ground-water investigations need the same structure and approaches that have been developed for air monitoring.

Two examples are provided in this paper to demonstrate how EPA certification and quality assurance requirements have been applied to the study of air pollution and how they may be subsequently applied to ground-water investigations. The first example covers a rationale for the certification of methods and instrumentation that proved to be successful in speeding the testing and certification of instrumentation for ambient air measurements. The designation of "reference methods," and a process for establishing "equivalent methods," is examined for the critical step

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of installing monitoring wells in a ground-water investigation. The second example applies some of the requirements for the documentation of basic quality assurance principles (contained in QAMS-002/80) to the relatively new science—as applied to ground-water quality investigations—of geophysics. Multiple disciplines and steps are required to understand the hydrogeology and ground-water quality in a ground-water investigation, and geophysics is one discipline and one step that needs to be considered in any ground-water investigation.

QA as Applied to Ground-Water Investigations

Ground-water investigations vary. Some are strictly concerned with defining quantity and flow parameters, others involve an investigation of ground-water quality. Some ground-water investigations are directed at relatively deep aquifers while others are directed at more shallow aquifers. Some involve the measurement of organic contaminants while others involve primarily the measurement of inorganic contaminants. Despite the diversity of investigations that are made in the field of ground water, certain basic principles apply to all of the investigations.

The sampling and analysis of ground water is important to a number of regulatory programs such as: Superfund, RCRA, the Underground Injection Control program, and Underground Storage Tanks (UST). The measurement of ground water involves the same basic concepts no matter which programs are involved. Monitor wells are drilled and sampled, and the water is analyzed. Common quality assurance procedures and guidelines may be developed and applied to all of the programs. It may be advantageous to do so since all of the programs ultimately focus on the same thing—the protection of ground water; however, there are some basic procedural steps in some ground-water investigations that will be unique to a particular program. For example, the quality assurance program and documents that are being developed for the Underground Injection Control program may not be directly applicable to any other area of ground-water investigations because the depth of the ground-water zone being investigated is distinctly different from the zone of concern near a RCRA or Superfund site. The focus of this paper will be on the application of quality assurance to the shallow ground-water investigations that are typically required in the investigation of a Superfund or a RCRA site.

Some of the steps in a comprehensive site investigation are given in Table 2. Each of the steps requires, in varying degrees, quality assurance procedures and documentation to ensure the collection of quality data. The applicability of quality assurance to some research efforts and to preliminary work can be questioned, particularly if few measurements are made. The manner in which the items in Table 1 are documented is generally not important. What is particularly important is that items addressing the reproducibility, comparability, accuracy, and precision of the data are addressed so that the quality of the data will be known.

TABLE 2—Steps in a multidisciplinary ground-water study.

Aerial photography/surveying
Search of available records
Geologic characterization
Hydrologic characterization
Geophysical studies (Subsurface and Surface)
Geochemical surveys
Soil sampling
Ground-water sampling
Source sampling
Exposure assessment
Data interpretation
GIS (Geographical Information System) data displays

The development of a reference method for the measurement of water quality parameters which leads to a superior monitoring method system to ensure that testing procedures. One method for the measurement of water quality parameters was designated as a reference method. The parameter for the reference method was first established by the EPA. It passed through a series of steps: the measurement of water quality parameters, further testing of the reference method had problems, however, a better method could be developed, defined. The process of equivalent was to be superior to the reference method was little disruption to a nationwide superior monitoring method system.

At approximately the same time, air pollutant, EPA designated an equivalent method. The use of a method, could obtain from the EPA specifications for the reference method, the basic requirement being that the method for every reference method had temperature, response time, drift, the establishment of the reference method began producing instruments that reference method. Response time as "equivalent" methods, and it phased out the wet chemical reference measure of the data quality from

The development of documented and rigorous standards and QA guidelines may produce undesirable results. The development of any QA program carries with it increased costs and paperwork, and these must be weighed against the benefits in knowing the quality of the data produced. Those in the private sector who develop a comprehensive QA program may actually be penalized in competitive procurements because the higher costs associated with the QA program would have to be passed along to the customer. If the customer had little interest or requirement for a strong QA effort, then a firm with a small QA effort and lowered costs might be chosen to perform the ground-water survey. Another disadvantage in requiring more formal QA programs is that proprietary processes may be revealed through the dissemination of the QA documents to competitors. Universal standards and QA guidelines would eliminate the possibility of proprietary processes being revealed and would presumably apply the costs of developing QA guidelines and procedures across the entire private sector; however, it is unlikely that any firm would go beyond the development of minimally required methods or standards.

Example 1: Reference and Equivalent Methods

The concept of equivalency and of performance standards strikes a balance between (1) the development of universal methods and standards, which might curtail the development of innovative methods and standards, and (2) the present situation of few industry or government standards, which leads to problems in comparing data and assessing the quality of that data.

Reference methods and "equivalency" have been used in the field of ambient air monitoring to ensure that basic standards are met without inhibiting the development of new methods and procedures. One such reference method was designated by the EPA for the measurement of sulfur dioxide. Important performance standards were provided by the EPA at the time the method was designated as a reference method, and test procedures were provided on how the important parameters for the reference method were obtained. When the reference method for sulfur dioxide was first established by the EPA, it consisted of a wet chemical method which required air to be passed through a series of impingers for 20 min. The response time, or performance standard, for the measurement of sulfur dioxide became 20 min. No method is perfect. It was discovered from further testing of the reference method that the measurement of sulfur dioxide by the wet chemical method had problems; however, EPA chose to continue with the method until such time as a better method could be developed or the weaknesses in the reference method could be further defined. The process of equivalency provided the opportunity that other methods, which proved to be superior to the reference method, could eventually replace the reference method; thus, there was little disruption to a nationwide monitoring program for sulfur dioxide while the search for a superior monitoring method occurred.

At approximately the same time as a reference method was established for the monitoring of an air pollutant, EPA designated test procedures and criteria for a method to be approved as an equivalent method. The user of a monitoring method, who sought approval of it as an equivalent method, could obtain from the Code of Federal Regulations the test procedures and performance specifications for the reference method. The tests could be performed by virtually anyone with the basic requirement being that the data had to be supplied to EPA for approval. Virtually every test for every reference method included an assessment of potential interferences, sensitivity to temperature, response time, drift and noise, and minimum detectable concentration. Shortly after the establishment of the reference method for sulfur dioxide, a number of instrument manufacturers began producing instruments that possessed superior characteristics to that of the wet chemical reference method. Response times were on the order of seconds. EPA approved the instruments as "equivalent" methods, and flame photometric and pulsed fluorescent instruments gradually phased out the wet chemical reference method. Through the transition period, EPA had some measure of the data quality from the reference and equivalent instruments, and private industry

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had design criteria that could be met or exceeded with little curtailment in the development of new technologies.

The degree to which reference and equivalent methods (and the related concept of performance standards) may be applied to various aspects of ground-water investigations varies. The reference method/equivalency process could be applied to the various disciplines that are involved in a ground-water investigation. One example where the concept may be applied is in the sampling of water from a well for volatile organics. Water from a well is evacuated for some number of well volumes or some period of time. A sample of water is drawn by some type of pump, bailer, or sampler and taken back to the laboratory for analyses. The water is then analyzed for parts-per-billion levels of a variety of organics, and an assessment is usually made on (1) whether the water is contaminated, and (2) the rate at which the water is being contaminated. The procedures for sampling a well and the composition of the well casing are interrelated. The composition of the well casing is important because it may affect the representativeness of the water sample if the casing adsorbs or desorbs organics. The method in which the well is sampled will influence the effect of the well casing material on the sample. There are several recommended approaches for the sampling of organics, but there are no "reference" methods. Likewise, there are no reference materials for the well casing.

Monitoring wells may be constructed from a variety of materials such as stainless steel, Teflon[®], fiberglass, or polyvinyl chloride (PVC). If one were to apply the concept of performance standards to just one component of this sampling procedure—to the well casing material—a reference material would be selected. An example might be stainless steel or Teflon. Suggested performance standards would include mechanical strength, chemical absorption/desorption characteristics, and manufacturing tolerances on the inside dimension of the casing (this would be important for the use of logging tools and pumps). Tests for the measurement of these parameters would be prescribed. Manufacturers who sought to market casings made out of nonreference materials such as Teflon-coated polyethylene, epoxy/fiberglass, Kynar[®]-coated steel, or even PVC would know the minimum standards that would have to be met for the successful marketing of their product. Formal approval would come after the data were reviewed and accepted. This process of developing standards, test procedures, and an approval mechanism should be an improvement over the present situation of no standards (or test procedures) and an ill-defined—if even existing—approval process.

Example 2: QA and Geophysics?

The application of geophysics to ground-water investigations is relatively new. Much of the pioneering work in geophysics has been for the petroleum and minerals industries. With the decreased exploration activities in these industries, private industry is eager to use geophysics in ground-water investigations, particularly Superfund and RCRA. Geophysical measurements for the petroleum and mining industries have not lent themselves to the development of quality assurance procedures and guidelines as specified by EPA in QAMS 002/80. The consideration of geophysics by regulators would be enhanced if the basic QA requirements in QAMS 005/80, which have been applied to the more established sciences, could be applied to geophysics.

The acceptance of geophysics by regulatory agencies depends first on the ability of the geophysicist to correctly describe the subsurface environment. Unique solutions are not easily obtained through the use of geophysics alone. The experience of the practitioner in geophysics and the supporting data provided to the person responsible for interpreting the geophysical measurements will determine to a large extent the success of the method in characterizing a site. The use of geophysics in ground-water investigations has been inhibited to a certain extent by the lack of standard, or uniform, data gathering and interpretation procedures; however, the application of uniform procedures to non-uniform sites may lead to unsatisfactory results if the procedures are followed blindly. Also, there are instances in some of the physical sciences where the

establishment of standards may be a costly, time-consuming, and technically difficult task. An example would be in the selection of a calibration standard or facility, or both, for a magnetometer.

The establishment of calibration standards or facilities, or both, for most instruments would be desirable if one were to compare data collected at different times with different instruments; however, the difficulty and lack of standards for the calibration of a magnetometer are not necessarily bad. The magnetometer measures the earth's magnetic field, which varies with time and location. In hazardous waste site investigations the magnetometer is often used to locate buried ferrous metal such as metal drums. Relative measurements of the magnetic field over a metal object are usually compared with readings over other areas. For example, it may not be important to know that the magnetic field over a drum was 50000 gammas or 50300 gammas. (Typically the magnetic field of the earth is on the order of 50000 gammas.) The important point is knowing the difference and rate of change of the magnetic field over an area. An absolute calibration of the magnetometer may not be required if the magnetometer was used only to locate buried drums. Thus, while it may be desirable to develop uniform standards and standard operating procedures in ground-water investigations, there is also a need for flexibility and a basic understanding of the method when those standards are considered and developed.

Perhaps the most important step in an investigation of a hazardous waste site is the documentation of how the data were acquired and interpreted. Since each site is different, it is difficult, but not impossible, to develop standard procedures for these steps. Describing a measurement process can be easy, but critiquing the process to improve the quality of the data and conclusions can be more difficult. Since the subsurface can neither be seen nor measured completely, the process of locating monitoring points or wells can be subject to a lot of uncertainty. Typically, "best judgment" is used. How does a client know, however, whether the decisions made by an investigator are indeed the best decisions? The development of standards by which data quality may be judged is important. A "standard set of data" may be submitted to the geophysical investigator for interpretation to ascertain whether geophysical data is being correctly interpreted. The "standard set of data" may represent voltage and current readings from a particular resistivity array at different electrode spacings.

The application of conventional QA principles becomes more complicated in critiquing how the data were acquired, for example, the location of the sampling points. Usually it is not known until an independent investigation has been performed whether a particular approach yielded the correct results. Monitoring wells may be drilled after a geophysical investigation to investigate the anomalies; however, even after this independent step has been taken it can be difficult to know how accurate or precise the measurements were in defining the magnitude and extent of the contamination. Data from a monitoring well may be representative for the small area near the well, but surface-based geophysical measurements may be more representative of a large volume of earth and water under the geophysical instrumentation.

Training and Certification

If the investigation of ground water, particularly at hazardous waste sites, is fundamentally an imprecise process and the development of standards is difficult for certain aspects of an investigation, it is nevertheless important to attempt to define how imprecise the process is. The establishment of documented standards and procedures is one step. The training of individuals in the use of the methods and in the application of QA principles is another step. An important step in assuring that ground-water data is correctly collected and interpreted may be the licensing and certification of the individuals and organizations involved in those investigations. Some professional organizations have a certification program for their members, while some states have licensing programs. Minimum standards of education and experience are established for the qualification of people in these programs. The certification process may be time-consuming and meet with some initial

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opposition; however, the present situation is not satisfactory. Qualified, certified geologists, hydrologists, geophysicists, and chemists, who are experienced in hazardous waste site investigations, are in short supply as compared to the great number of sites that require sometimes complex and costly studies.

The Future

These examples and arguments buttress the position that greater attention and resources need to be devoted to QA for the various disciplines that are used in a variety of ground-water investigations. There is a growing recognition by government, industry and academia of the need for greater QA; however, who will be responsible for the implementation of a QA program, and how will it be developed? The EPA has responsibility for ensuring that QA is considered in the studies it authorizes, but past and present efforts to improve QA in ground-water studies have been inadequate. Further, other government agencies and private organizations that do not fall under the EPA umbrella are conducting ground-water studies. Professional societies such as the SEG, NWWA, American Institute of Professional Geologists, American Institute of Hydrologists, and ASTM have begun to recognize the need for the development of standards, but they do not represent all those who are involved in ground-water studies. There needs to be a coordinated effort between the organizations who represent the professions that are employed in ground-water investigations because the study of ground water is an interdisciplinary science. The best approach appears to be a team approach in which all professionals recognize the need for greater QA in their professions and work towards that end. While it may take some time to form the team of government, private industry, academia and the professional organizations, the joint effort, with proper guidance, could lead to the establishment of standards and QA principles that may be characterized as a blessing rather than a curse. It has to be done if the challenges are to be met in cleaning up thousands of hazardous waste sites and monitoring the multitude of aquifers in the nation.

Reference methods, with procedures for demonstrating "equivalency" to those methods through the establishment of "performance standards," allow for innovation in the attainment of those standards. EPA could establish this concept in its ground-water programs as it has in the air programs; however, the process will not be easy, quick or universal. Guidelines could be established for how the reference/equivalent methods would be applied to a site investigation, but again the responsibility rests with the investigator to use "best judgment" at a site in the selection of the monitoring location and methods. Reference methods, equivalency, guidelines, and rigorous QA requirements proved to be useful in the 1970's in the air pollution sciences, and these concepts may prove even more useful in the 1980's in ground-water studies.

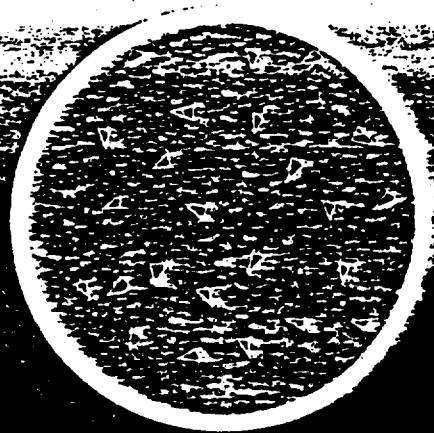
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